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AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.
ISSUED WEEKLY BY THE AMERICAN MACHINIST PRESS,
Vol. 25. 218 WILLIAM STREET, NEW YORK. No. 1

Index to Advertisers and Classified Index Following Reading Matter.

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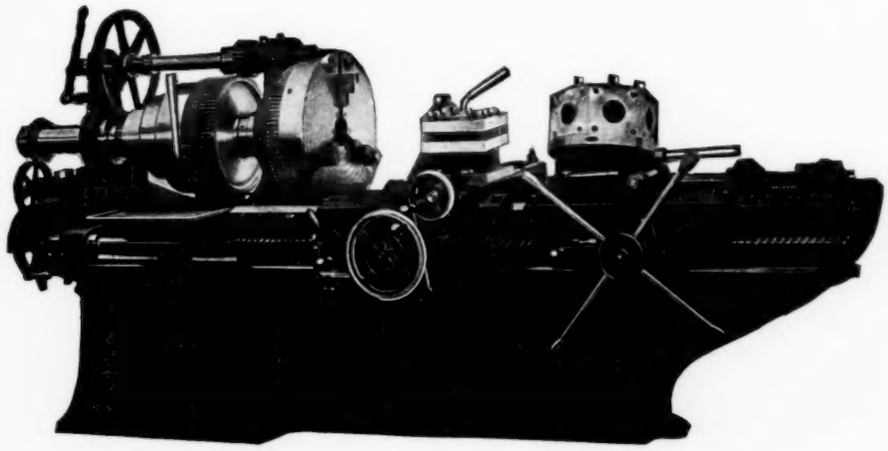

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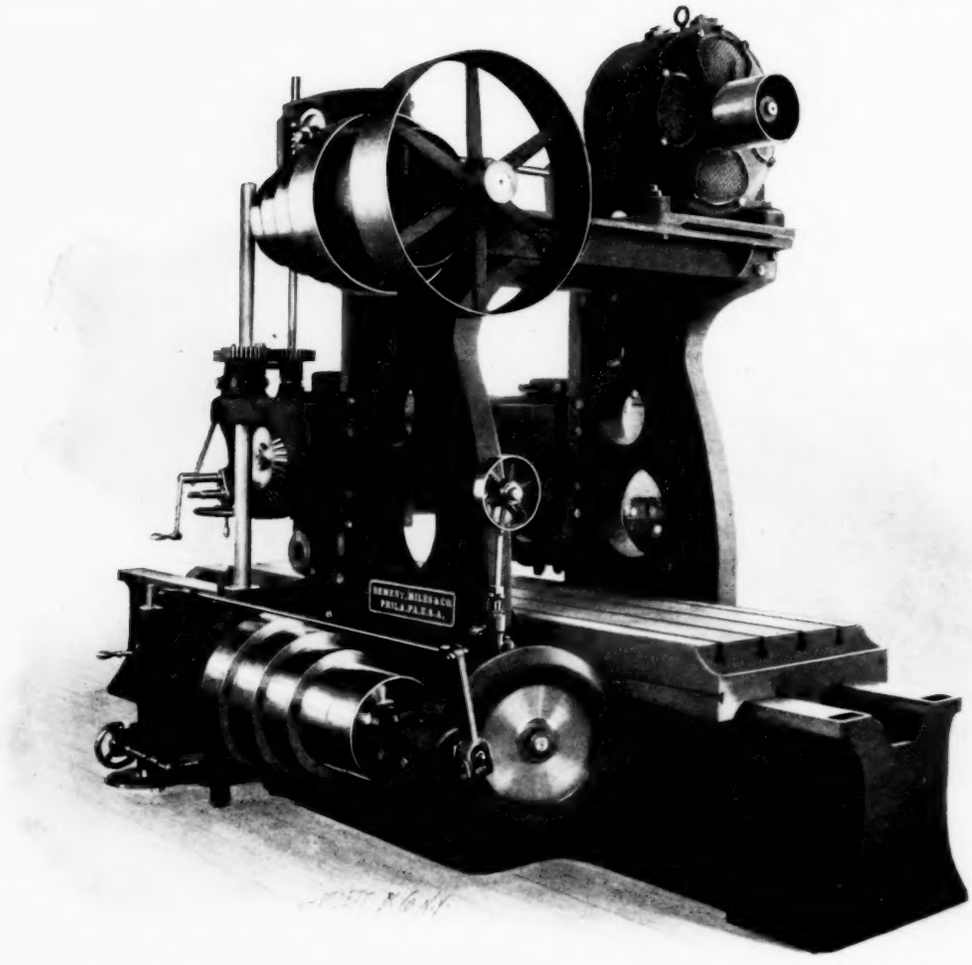

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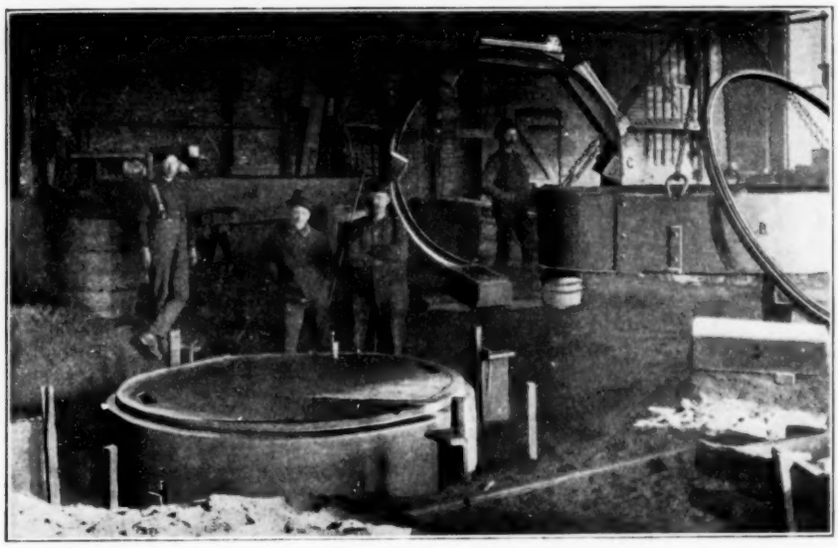


FIG. 1. THE MOLD BEGUN.

Casting Bases for Upright Boilers.

BY R. H. PALMER.

The half-tones are from photographs taken in the foundry of Wm. Allen & Sons, boiler makers, Worcester, Mass. In Fig. 1 can be seen a part of the pattern of a boiler base, or ash pit, for an upright boiler, with one of the molders standing behind it. The other part *B* of the pattern is seen leaning against the "cheek," the whole being molded in what would be called a three-part flask, but in this case what would be the nowel, or drag, is bedded in the bottom of the pit. The core or center is seen in the foreground in Fig. 1; at the back is seen the cope and at the right the cheek.

In making the flask a pattern of a section of the cope was used and moved around the circle as fast as rammed up, and the cope was then cast in open sand, trunnions and lugs being formed by using cores. The cheek of the flask was a ring cast in open sand with six uprights on it the depth of the cheek—some 24 inches—to which are bolted around the outside plates of boiler iron.

In molding the base a spindle is located in the center to which is attached an arm or sweep, and a level bed is first swept. The cheek is next centered around the spindle and rapped down to a solid bearing. Ring B, Fig. 1, a part of the pattern, is now laid on this bed, and sand is rammed between it and the ring of the cheek, which ring is beveled so as to bring a thin edge to the ring *B*.

The part *C*, Fig. 1, of the pattern is now placed on the ring and the outside is rammed up. Cores are placed on the inside of the pattern, leaning against it, to form the inside flange seen at *D*, Fig. 2, and at the right hight gate cores *F*, Fig. 2, are placed. After the cheek is rammed up the cope is guided into position. The whole being rammed up, the cope is swung at the back, pattern *C* is drawn and then

FIG. 2. THE CHEEK READY TO LOWER.

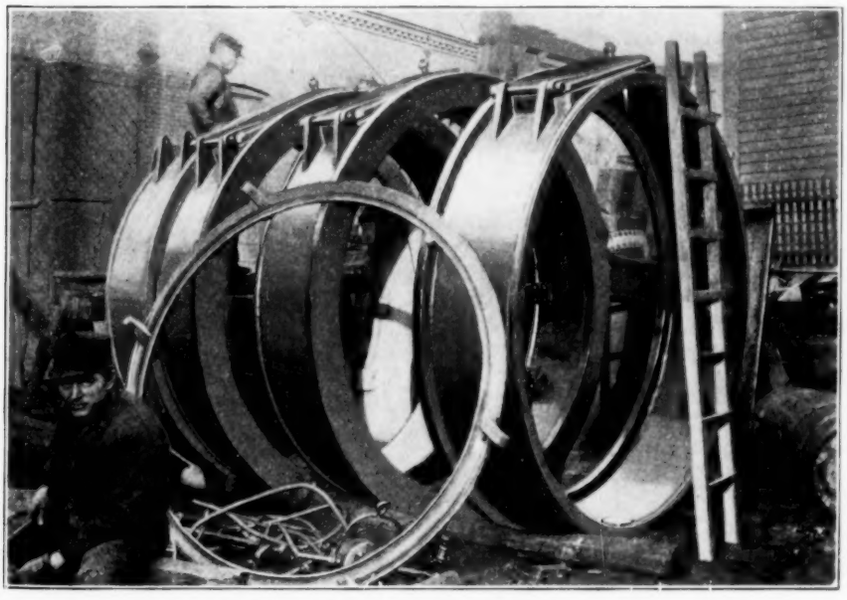


FIG. 3. FITTING UP THE BOILER BASES.

the cheek is lifted off, four toggles being hitched to uprights, as seen in Fig. 2, and part *B* of the pattern is drawn. After finishing the cheek lug cores *E* are placed and filled over in the drag. When finishing the cheek the lugs for hinges are drawn inward. Openings to form them are seen at *K*. These have to be securely rodded and vented around. The cheek being replaced, cores *D*, Fig. 1, are placed to form openings for ash doors. The mold is secured with two binders above and two below, the latter covered with boards on which the mold is built, and the two sets of binders are bolted together.

The next morning after pouring the casting was removed, the cheek was cleaned out, and, after being allowed to cool, about 1½ inches of sand was cut from under the face of the ring and the process of molding was commenced again inside the cheek. In this way ten castings

were made, the same seating of the cheek answering for all and no loss occurring. In starting the second the sweep used can be seen at *A*, Fig. 2. Fig. 3 shows a number of the castings in different stages of completion while in the hands of the machinists. The average weight of the castings was about 3,800 pounds.

Some Jobbing Shop Methods — Cutting a Coarse Pitch Screw — Making Thin Threaded Brass Rings — A Stepping Jig for Drilling a Lot of Small Holes — Spring Winding — Making Spring Collets.

BY JOSEPH V. WOODWORTH.

Fig. 1 is a sketch of a coarse pitch screw which, because of the unusual coarse pitch, was cut and finished under difficulties.

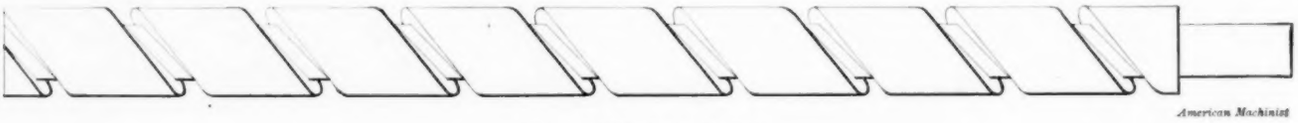


FIG. 1. SCREW TO BE CUT.

The screw was 30 inches long, 2 inches in diameter and with one thread to 3 inches. After rigging up the gears on the strongest lathe in the place it was found that the slowest speed we could get was too fast, and after ripping all the teeth out of two gears, it was decided to adopt means which would allow of the work being rotated slowly enough for the thread to be cut. A new pair of gears was got out to replace the broken ones. A piece of machine steel was then turned up and reduced at one end to screw into the tapped hole for the gear screw in the end of the lead screw of the lathe, and an 8-inch pulley keyed on this extension piece. A spare countershaft was now located and fastened to the floor. The driving belt was removed from the lathe and we then belted from the main shaft to the countershaft on the floor and from the countershaft to the pulley on the lead screw. We thus reversed matters, and instead of the lathe spindle driving the lead screw, we had the lead screw drive the spindle. Thus while the lead screw fed the thread tool at the proper speed the work turned very slowly and the screw shown, and several others as well, were finished without any further trouble.

In Figs. 2 and 3 respectively are shown the means used for accomplishing a nasty little job in a very simple manner. We were making a lot of thirty-two acetylene gas lamps, and during the process of manufacture it was necessary to make and sweat a threaded brass ring into one of the shells. These brass rings were made from 2-inch brass tubing and were required to be finished to ⅜ inch wide and threaded 22 pitch. The tubing had a wall of only 1-16 inch, and it was impossible to cut off and thread the rings in the usual manner in the lathe, so the following simple means were used: A piece of soft wood was turned up on centers to fit a length of tubing, as shown in Fig. 2—finishing one end somewhat smaller than the other, so that the tubing could be forced on. Then by driving this wooden arbor between the lathe centers, the rings were cut off with ease, as shown, without in the least affecting their trueness. After being cut apart the rings would come off the arbor easily. The burrs were then removed with a hand tool, and the rings were threaded by holding and locating them in a wood chuck of the shape shown in Fig. 3. This chuck was of soft wood and was turned at *G*, so as to allow of its being held in the regular lathe chuck; then bored out on the face, so that a brass ring would fit tightly within it and true itself against the shoulder at *H H*. Four round-head screws at *J J J*, when tightened down against the edge of the ring, also helped to hold it The rings were threaded in this manner by the usual threading tool and fitted to a plug, and were removed from the chuck by screwing the plug in for a few threads and pulling the ring out. Some of the rings would not fit tight, but by taking a piece of wet waste and wetting the locating portion of the chuck, it would shrink sufficiently to hold. Anyone who has ever tried to do work of this kind with the usual means at hand in the lathe will appreciate this simple and effective method.

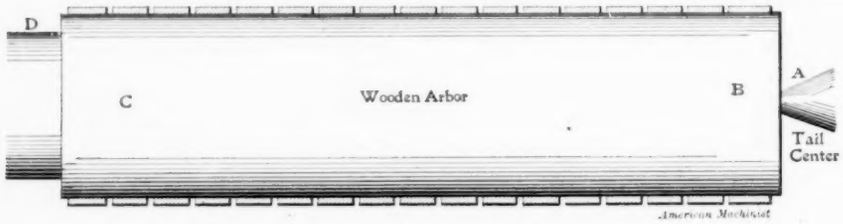


FIG. 2. CUTTING OFF RINGS.

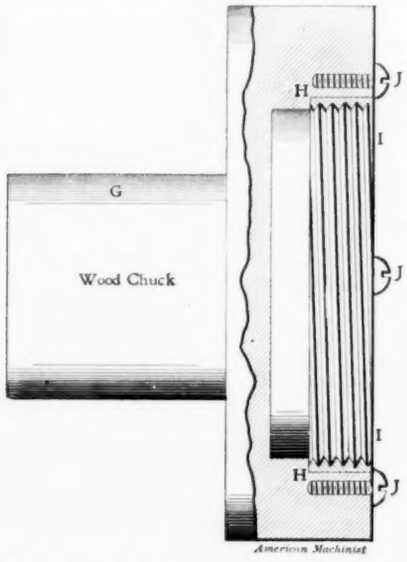


FIG. 3. CHUCK FOR THREADING BRASS RINGS.

The sketch, Fig. 4, shows how an unusual job was accomplished in a simple manner with the best means available, which were, to say the least, not meant for the job. The work was a base casting of a two-cylinder pump model, and it was necessary to bore two 1¾-inch holes in it in the positions shown. The lathe we had was too small to allow of swinging it on the face-plate, and the only drill press in the shop (which was a private experimental shop) was an 8-inch sensitive drill. So by means of the adjustable cutting tool shown we did the job on the small drill. First we drilled and reamed two small holes the required distance apart for the centers, as shown at *K*, as locating and truing points of the tit *M* of the tool *R*, as shown. The tool was fastened in the chuck and the work located and clamped to the table, and the holes finished as shown in the sketch. The tool used for this job can be used for a variety of others as well.

The sketch, Fig. 5, is meant to show one end of a hard rubber plate which was accurately finished on the sides to 7⅜ inches wide, 5½ feet long and to ⅜ inch

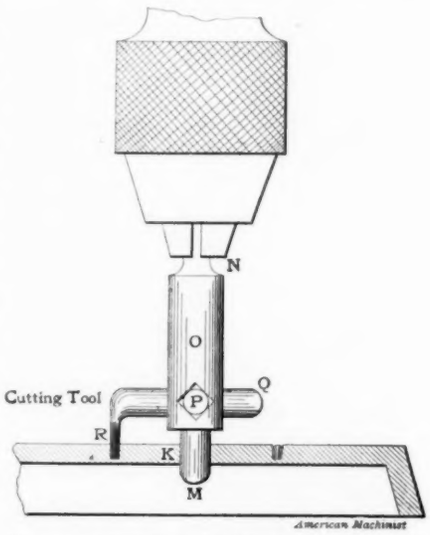


FIG. 4. METHOD OF MAKING LARGE HOLES ON A SMALL DRILLER.

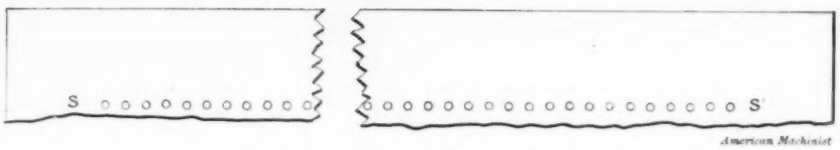


FIG. 5. SECTION OF HARD RUBBER PLATE TO HAVE 32,500 HOLES.

thick. In this rubber plate there were to be drilled fifty-two rows of holes, ⅛ inch apart and 625 holes in each row, the size of a No. 60 drill. The number of holes in all was 32,500, and each and every one

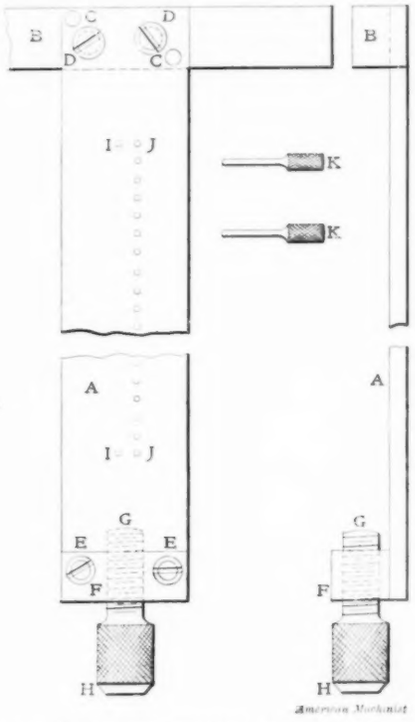


FIG. 6. JIG FOR DRILLING RUBBER PLATE.

of these holes was required to be accurately spaced, as the rubber plate was to be used as part of the mechanism of a music box, a steel pin being afterwards inserted into each hole. There was to be a ½-inch margin on all four sides of the plate.

The jig used for drilling and spacing the holes is shown in two views in Fig. 6. And as the sketch explains itself, very little description is required. As shown, there is one row of fifty-two holes running in a straight line from *J* to *J*, and ⅛ inch from the holes at the extreme ends of this line other holes as shown at *I I*. These two holes are for spacing the rows of holes in the plate when drilling, by drilling the first row ½ inch from the end of the plate and then locating the jig for the next row by inserting the two locating pins *K K* into and through the holes *I I* and into those coinciding in the plate. The holes in the jig were spaced and located in the universal milling machine by using a small stiff center drill for centering all holes, and afterwards drilling and reaming them on the sensitive drill. The manner in which the jig is used and the work drilled can be understood from the sketches. The drilling of these 32,500 holes took some time, and after each day's work on them it was necessary to lay the rubber plate on the planer bed and put heavy weights on it so as to prevent it from warping during the night.

I saw the following combination used to advantage one day while looking through a small country jobbing shop. It consisted of a 1-inch drill, a lathe center, a dog and a stick of wood about 3 feet long. They were used for drilling three 1-inch holes in the bed of an old planer. The lathe center was clamped in the tool-post of the planer and the dog fastened to the shank of the 1-inch drill. The point of the drill was entered into a center-punch mark in the planer bed and the point of the center entered into the shank end of the drill. With one hand the drill was turned by using the stick of wood as a lever, and with the other the tool head was fed down. In this manner the holes were drilled. While the use of the lathe center and the cross-head as an "old man" was all right, I thought that the dog and stick method was rather obsolete, until the "boss" of the place told me that they had no ratchet.

Fig. 7 shows two views of a simple and handy little spring-winding fixture which, as the sketches show its construction clearly, requires little description. The body *T* is a piece of finished ½-inch square mild steel, and one end is constructed and fitted for winding gaged springs, while the other end is for closed springs. The end for the gaged springs has a hole through it at *Z* for the rod *L* on which the spring *M* is wound. For a gage for winding the springs, the spring *U* is used, it being located and fastened to the side of *T* by the small clamp *V*. *V* is a small plate fastened to the body at *X*, with a guide-way at *W* for the wire. When in use the rod *L* on which the spring is to be wound and the end of the wire is fastened in the lathe chuck the projecting end of the rod entering the hole *Z* in the winder; then the winder is given a couple of turns around the rod, so that the gager *U* will have twisted around the wire. The fixture is then fastened in the lathe tool-post and the lathe started, holding the wire tight by hand and letting it run down the guide-way *W* as shown.

The other end of the winder is used as shown. The screws *P P* and *O O* are for adjusting a guide-way for the wire which passes under the roller *Q* and is wound around the rod *S*, as shown at *R*.

One of the handiest things around a jobbing shop is a soldering face-plate. The number of small, odd and intricate little jobs which can be accomplished with ease by its use is surprising. The one we have is fitted up to locate and fasten on the face-plate of the Hendey-Norton lathe, and consists of a disk of cast composition about 1 inch thick and slightly under the diameter of the face-plate. After being faced on one side it was located and fastened to the face-plate by means of four countersunk head screws which were let in from the back, thus allowing of its easy removal when through with it. One of these plates should be kept in every tool-room, and one 1-inch thick will last a long time and pay for itself over and over again before being worn out.

The following kink I have found very handy when making collet spring chucks of the shape shown in Fig. 8. After finishing them in the lathe, leaving, of course,

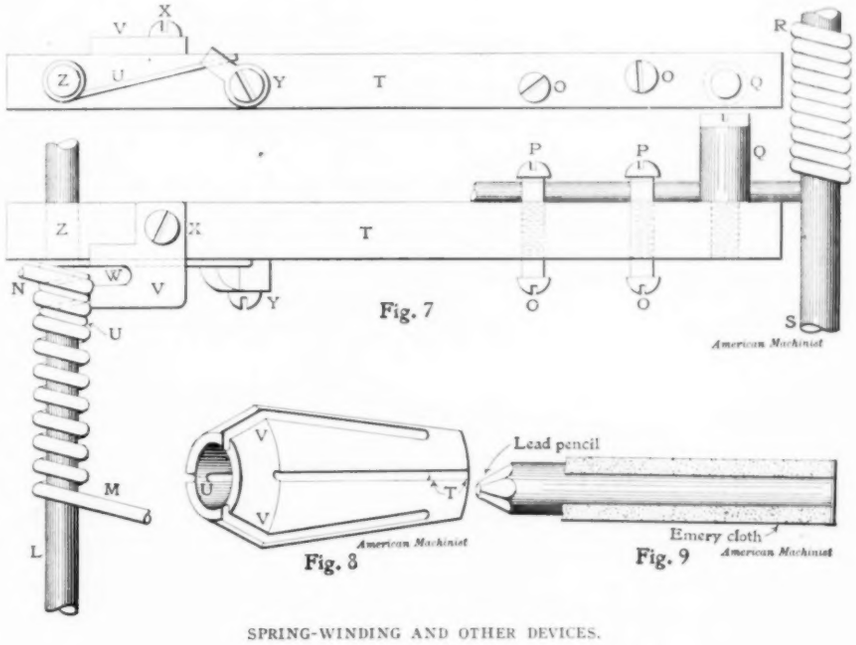


Fig. 7

Fig. 8

Fig. 9

SPRING-WINDING AND OTHER DEVICES.

enough stock to lap and grind to a finish, face them on an arbor and saw the spring slots as shown—that is, at the end of each slot, as shown at *T* and *V*, instead of cutting completely through at this point, leave a very thin wall about ⅛ inch long at the end of all the cuts. Then harden and temper the chucks, as desired, and after lapping the inside to size, place on an arbor and grind the tapers as required; then take a small, narrow broach and by entering it into the slots and hitting it a sharp blow with a hammer the thin wall will break through. This kink I have used to the best advantage in shops which had no grinding facilities. When proceeding as aforesaid, it was possible to finish the outside and tapers to size before hardening without the possibility of the chucks running out to any noticeable extent. Of course for work of the utmost accuracy this method would not do. But then again work of the utmost accuracy is not accomplished in shops where the tool facilities are not up to date.

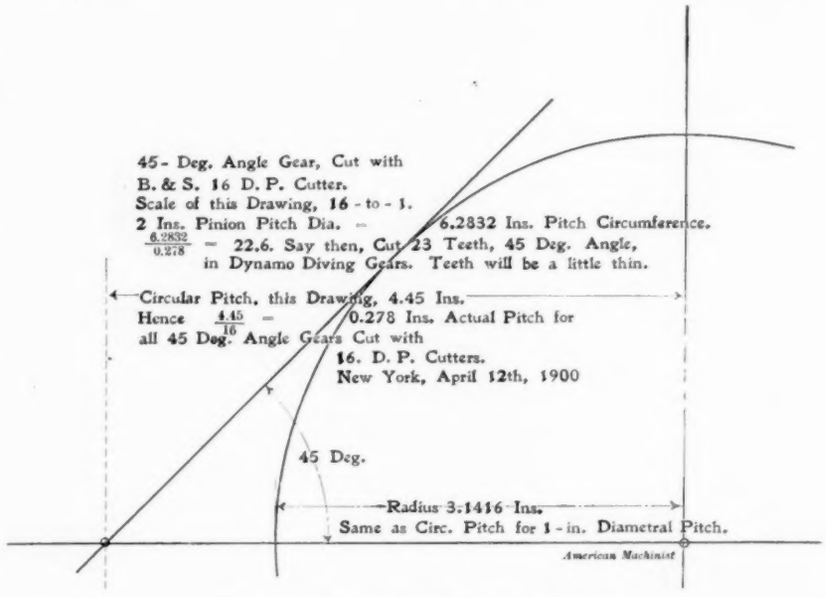
In Fig. 9 is shown a sketch of a little kink which, while no doubt old to many, may be new to some. It is a flaking stick and may be used for producing that circular flaking often seen on the inside of watch cases and often desired for a finish on different polished small parts. It consists of a stump of a lead pencil with one square end and a piece of emery cloth. As shown, fastening the cloth around the stick and fastening both in the chuck of the small drill press, then running it fast and coming down on the work for a second and then shifting it and coming down again. The finished effect is fine when a little care is taken to move the work evenly.

Some time ago there appeared an account in one of the trade papers of a lathe hand, who, when about to turn a taper shaft, proceeded to shift one end of the lathe with a crowbar. The hero of the following I think beats him. About a month ago we hired a man of about thirty-two as a lathe hand. He was put on a lathe and the first job given him was a lot of small pulleys to turn and crown. He was told to take one of a finished pile that another lathe hand had finished, as a sample, and go ahead. As he seemed to be very busy, and as at regular intervals a finished pulley would appear on the floor at the side of his lathe, it was late in the afternoon before the foreman got around to see how he was getting along. The foreman, noticing the pile of finished pulleys on the floor, congratulated himself on the fact that he had got a hustler, and as it put him in good humor he asked the man how he was getting along. The lathe hand grinned and taking up a pulley he had just finished, placed his scale along the face and said: "Fine. See, mine are all flat on the top, but the other fellow's are all round! He, he!" It is needless to remark that the next morning there was another man at that lathe.

Spiral Gears Set at Ninety Degrees.

How easy it is to be proud and fall down! It might seem that an old, old man, shaky on his pins, with no teeth and no memory, gray as a rat and deaf in one ear, had very little ground left for personal pride to stand on; but I do pride myself on writing unmistakable English, and giving shop orders which produce the work I expect, and yet my spiral gear article, carefully written, and printed as I wrote it in the "American Machinist," No. 49, page 1337, was misleading to the very first man who read it, and misleading to such an extent that the "American Machinist" editor who handled the article thought it needful to tag it with a footnote, warning the "American Machinist" readers that the graphic solution of spiral gear problems which I exhibited with so much pride gave 41 per cent. of error for a 45-degree angle tooth.

This makes me sad.


45 - Deg. Angle Gear, Cut with
B. & S. 16 D. P. Cutter.
Scale of this Drawing, 16 - to - 1.
2 Ins. Pinion Pitch Dia. — 6.2832 Ins. Pitch Circumference.
6.2832 / 0.278 = 22.6. Say then, Cut 23 Teeth, 45 Deg. Angle,
in Dynamo Diving Gears. Teeth will be a little thin.
Circular Pitch, this Drawing, 4.45 Ins.
Hence 4.45 / 16 = 0.278 Ins. Actual Pitch for
all 45 Deg. Angle Gears Cut with
16. D. P. Cutters.
New York, April 12th, 1900
45 Deg.
Radius 3.1416 Ins.
Same as Circ. Pitch for 1 - in. Diametral Pitch.
American Machinist

MR. RANDOL'S FIRST SPIRAL GEAR DIAGRAM.
THE ENGRAVING IS REDUCED FROM THE DRAWING, AND THE STATEMENTS BASED ON THE SCALE OF THE DRAWING DO NOT APPLY TO THE ENGRAVING.

The spiral gear tooth diagram, Fig. 1, page 1338, gives absolutely correct graphic answers to all shop questions in spiral gears of any tooth angle. It is very simple, and is original with me, and I do not think any similar diagram for the same purpose has been previously shown. If I am not the first to use this diagram, its publication in the "American Machinist" will probably bring out the name of the first inventor of it, who deserves great credit, be he myself or another.

The first use I made of this diagram, shown in Fig. 5, is for 45-degree angle teeth, and does not give 41 per cent. of error, nor any other per cent. of error; it gives correct results. If it did not give correct results I would not insult the "American Machinist's" readers with it.

As I have no memory to trust any more, I am forced to note all particulars on my drawings, and the here reproduced first spiral gear diagram, date April 12, 1900, contains in the figure and text all I knew about it at that time. I did not know at that time that the diagram would give all solutions for all angles of teeth, but I soon found that it would do this, and have used nothing else since for laying out spiral gear teeth.

The editor says that the real "liberty" I take is in assuming that a gear cut 13-degree angle has the normal circumferential pitch. I thought I took a heap of liberties all the way through in using incorrect numbers of teeth and incorrect spirals, and in making use of a very simple diagram which by one setting of the bevel T-blade solves all questions relating to cutting spiral gears with spur gear cutters.

The editorial remarks read as if I proposed to use the normal circular pitch of the cutter employed for one of the gears in all cases. How this queer misapprehension came to befog the editorial mind, I cannot quite understand. I remember that the editor made the remark that teeth of the normal thickness were 41 per cent. too thick for 45-degree angle teeth, and that as I saw no connection between this remark and the subject under discussion, I made no definite reply thereto.

Had the editor said, what now appears to have been in his mind, that my diagram gave teeth 41 per cent. too thick for a 45-degree angle, I should have at once made the matter clear to him.

In the spiral gear article I say, foot of third column, page 1338, "Now set a bevel T-square to 13 degrees," and so on.

I should have made the instruction general instead of specific, by writing "Now set the T-square blade to the assumed angle," and so on. In case of 45-degree

angle gears a right-angle square blade and 45-degree angle set square only are needed.

Also, I should have included Fig. 5 in the illustrations of the original article. The article was much longer than I wished and I left Fig. 5 out, and so gave opportunity for an erroneous conception on the part of at least one reader.

I have a crow to pick with this "American Machinist" editor anyway. I said in the original article that the editor had seen the particular pair of gears which I wrote about, in action, and would say that they ran well, and that the 13-degree toothed gear drove the 77-degree toothed gear quite strongly. To make good, I induced this editor to go to Richard's laboratory, where I showed him the gears set up both ways and driven in his presence, so that he could editorially say that I told the truth about the running of the "hogged" job of spiral gear cutting, and he said that he would do so. Instead of that his editorial footnote said that for a 45-degree angle tooth my diagram would give a 41-per-cent. error, and never mentioned seeing the gears at work at all.

I am not disposed to be captious, and if the "American Machinist" will kindly print this and Fig. 5 with it, and so clear me of its editorial assumption that I am in the last stages of senile dementia, and will say editorially that he saw the "hogged" spiral gears running nicely, I will not ask anyone at all to "go 'way back and sit down." JOHN RANDOL.

[As it is our turn at the bat we will explain that we did not criticise Mr. Randol's diagram at all. We said—page 1340, middle column—"The chief real liberty taken is in using the normal or cutter pitch for the circumferential pitch in the case of the slow gear, and this is possible because with the low angle the two pitches do not greatly differ." There is no possible ambiguity here. This use of the cutter pitch is at page 1338, third column, *before the diagram was so much as mentioned.* After giving the diameter of the gears and the diametral pitch of the cutter to be used he finds the pitch circumference of the gears to be 9.965 inches and adds (italics are ours): *"For the slow gear assume a tooth angle so small that it need not much influence the tooth thickness.* In this case 13 degrees tooth angle was assumed for the slow gear, which makes the tooth a very little thinner than normal. The circular pitch of 16 diametral pitch, per Brown & Sharpe's book—which is on every draftsman's table in the United States, or should be—is 0.196 inch, and the pitch circumference being 9.965 inches, gives $\frac{9.965}{0.196} = 50\ \frac{165}{196}$ as the correct number of teeth, which is an impossibility; hence as the teeth are known to be a little thin, say 50 teeth, making the teeth a little thicker, instead of 51 teeth, which is nearer right, but is an awkward number and would make the teeth yet thinner."

That is to say, he divided the pitch circumference of the gear blank—9.965 inches—by the cutter or normal pitch—0.196 inch—in order to obtain the number of teeth, which is to say again that he used the normal pitch for the circumferential pitch, and, as we said before, "this is possible because with the low angle (13 degrees) the two pitches do not greatly differ." We repeat that the error—that is, the difference in the two pitches—would increase with the angle, until at 45 degrees it would amount to 41 per cent., which would clearly make it impossible to determine the number of teeth in a gear, as Mr. Randol did in the case of his slow gear.

Instead of criticising the diagram we, in effect, endorsed it by saying that "it is certainly a neat way of finding the circumferential from the circular pitch." If more than this is wanted we will add categorically that the diagram is correct. It gives the correct circumferential pitch of both gears and for any angle, but Mr. Randol used it for finding the circumferential pitch of the high angle quick gear only, the normal pitch of the low angle slow gear having been previously used in finding the number of teeth in that gear, where, strictly, the circumferential pitch should have been used, and where it must be used if the tooth angle is a large one.

To sum the matter up, Mr. Randol set out to show, by an actual example, that accuracy in spiral gears is unnecessary. Thus in one place he said, "pay no attention to the discrepancy," and in another "never mind trifles," and toward the end he said regarding the gears made: "Everything so far in this example is wrong: nothing is accurate or as it should be." Regarding these discrepancies, trifles and inaccuracies, which we called "liberties," we said: "These liberties are not all, however, as large as he seems to think," and we stated that for the conditions the error in the tooth angle was only 19 minutes, while the calculated numbers of teeth were 10.64 and 49.6, for which he had used 11 and 50. However rough and ready the methods may have been, the results happened to be nearly right.

So far from our having misunderstood Mr. Randol, the fact is that he has misunderstood us, although we fail to find any lack of clearness in what we wrote.

We add with great cheerfulness, as we should have done before, that we saw these gears operate, that the action was perfect and that the 13-degree angle gear drove the 77-degree angle gear as described by Mr. Randol. Considering the smallness of their errors, they run exactly as they would be expected to run.—Ed.]

A company is said to have been incorporated in Canada to manufacture on a large scale the famous rifle of Sir Charles Ross. It already has a contract with the Australian Government for 50,000 small arms and is expecting an order from the Imperial Government for 100,000.

Echoes From the Oil Country.

READY TALK WON.

"Here, Osborne, is a matter you had better attend to. From this letter I see they want me to go up to the lake and give them some expert advice about a pump. The man that wrote that letter is well educated, and goodness knows what kind of fine-haired scientific knowledge he may be looking for. You're not much good around here with that sore hand, as far as work goes, but that won't keep you from talking. I will look after things here, and you go up and see to this and explain to him that I am so busy with important work that it is impossible to get away. A man has to keep his reputation, even if it is a little too big, and I might lose some of mine if I got up into a strange country where folks didn't know me."

It was Mr. Smith that was speaking, and I took the train, as he directed, with a very vague idea as to what would be wanted. I found that the gentleman ran a large hotel. The water for many purposes was pumped from the lake into a tank that was up in the attic under the roof. The pump was of sufficient capacity to give more water than it was found they needed, and it was shut off whenever the tank was nearly full and started again when it was nearly empty. Floats were rigged to show in the basement, so that the man in charge would know.

The pump was down by the lake shore; it could be seen from the engineer's room in the basement. Sometimes, when steam was turned on, the line would be full of water and the pump had been stopped at such a place that it would not start, and then the man would have to go down and work it back and forth by hand to get it started. To save annoyance to the guests the pump had been well piped, with an ample air chamber, and there was no noise to indicate whether the pump was running or not, so the man had to depend on seeing the exhaust to know.

In the expansion of business it became necessary to add to the hotel, and this addition cut off his view, and made it so that he had to go some distance to be able to see the pump, and as he was a handy man for all sorts of repairs during the busy season, he did not have the time, so he wanted the pump moved near him. He had another reason, too. He thought the pump was doing too much work in shoving water up to the top of the building, and if it was moved up it would have that much less work to do.

The owner had some vague idea that there was a limit to the distance a pump could draw water, but whether it was hight or length he didn't know. His man contended that it didn't make any difference how low down or how far away the lake was, if only a check valve was put down by the lake and the pipe filled to the pump; then all the pump had to do was to take it out of the top of the pipe, and now a man was wanted to decide the matter, or

at least to take the responsibility of a failure in case the pump was moved.

"It's no use trying to make any change there. It wouldn't suck water more than half that high," I remarked, as soon as I had looked the ground over.

"How high will it suck water?" asked the owner.

"It might suck it somewhere from 20 to 25 feet," I replied.

"And how high do you call this above the lake?" put in the engineer.

I was hardly prepared for a close estimate on that, as the lake was several hundred feet away and the water, stretching out beyond, gave it a strange look to me, but I ventured 40 feet. This was at once combatted by the engineer, and the owner was soon on the fence. I labored with him earnestly for several minutes, and he said he guessed I was all right if I could only show how high we were above the lake. Fortunately, the engineer had a carpenter's level, and I found a piece of reasonably straight board and set it to aim at a tree by the lake front and leveled it. The engineer quietly told the owner that I was pointing it away too high, and when I walked to where he was viewing it from it did look high. As it was his level, I let him level the board, turning the level end for end to prove it was true; then, of course, he couldn't go back on his level, for he had been swearing by it in all his own work all over the place.

With two long fishing poles tied together, with a rag on the top end, climbing up on a small building by the tree enabled us to get a measure, which proved to be nearly 47 feet. I thought that settled the matter pretty effectually, but the engineer wanted to dig a hole up by the hotel and set the pump down into it. I think my suggestion that any leak would make a well of the hole and that he would have to climb up and down frequently had more to do with his not pressing that idea than anything I said about the pump not sucking up over the hump in the ground.

Then another thing they had often discussed was brought up. The pump discharged up through the bottom of the tank, and the man wanted it changed so that the pump wouldn't have to pump against the whole size of the tank. He was for changing the pipe to run up alongside of the tank and discharge over the top, the discharge pipe to go down nearly to the bottom of the tank. This last was to avoid any noise the water might make falling into the tank when it was used down low.

Of course, I told them to leave it as it was, and then I had to go into the reasons. I poured out all I could think of about friction in pipes and the loss due to elbows, called attention to the greater hight that the water would have to be lifted and tried to make it plain that the pressure on the pipe was per square inch, and that the size of the tank didn't cut any figure. When I had said all I could think of, the owner asked the engineer what he had to say, but he evidently hadn't expected such a deluge over so small a matter, and had very little to say.

As the owner was going to the depot with me, he remarked that he was glad to have these things settled, as George was a real good man, but when he got a notion it was hard for him to give it up.

"No doubt you plainly saw as soon as your attention was called to it that he had gotten wrong ideas in both cases," I replied. He began to laugh.

"I don't mind telling you now," he said. "I haven't the slightest idea, as far as any real knowledge goes, which is right."

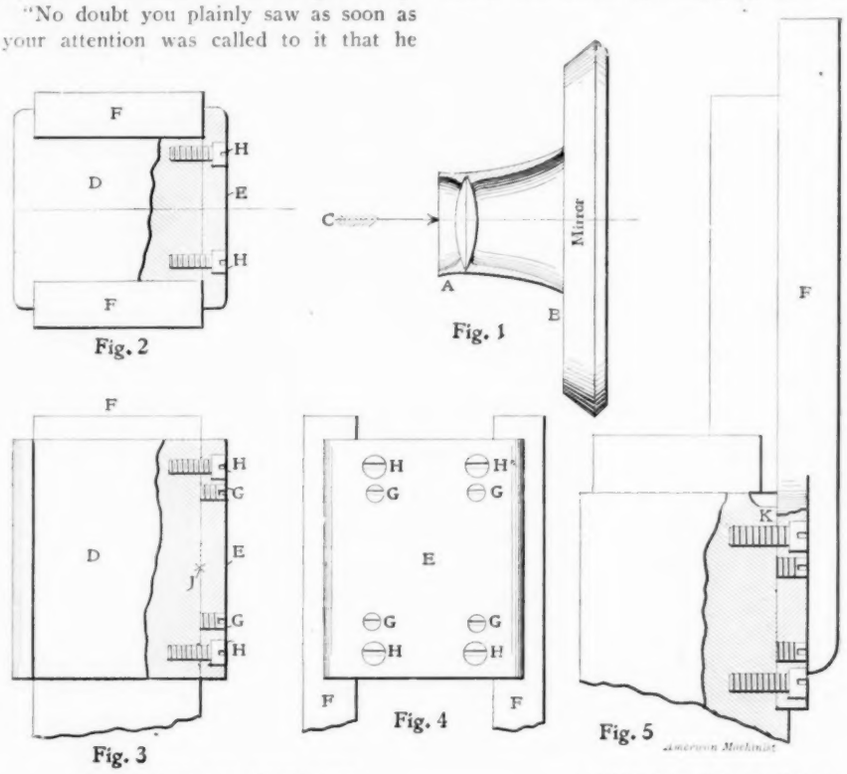
"Well, I don't understand why you side in with me in that case," said I.

"Oh, that is simple enough. I just got you both talking, and I found that you talked it right off, like as though it was easy; and to do that you must know what you are talking about. George would make some pretty flat statements, but he hadn't much to offer to support them, so I side in with you."

He was a much older man than I, and he had seen a lot of the world, so I concluded it might be of some use to a machinist to be able to spread out what little knowledge he had on certain occasions.

W. OSBORNE.

An important and costly machine was nearly finished, but when it came to the assembling it was found that some gear wheels inside of the frame of the machine came in such a position that there was not sufficient clearance, and in chipping out clearance for them a hole was chipped through the front of the frame of the machine in such a way as to be very conspicuous. Here was a problem for the designer and the manager, who, in this case (fortunately for him) happened to be one and the same person. The hole, palpably made for this purpose, would not do at all. At the same time it could not be fixed in any way which would have been right or have looked right. The difficulty was solved by enlarging the hole,



ADJUSTMENT FOR SLIDING FIT. ADJUSTMENT FOR STANDARD.

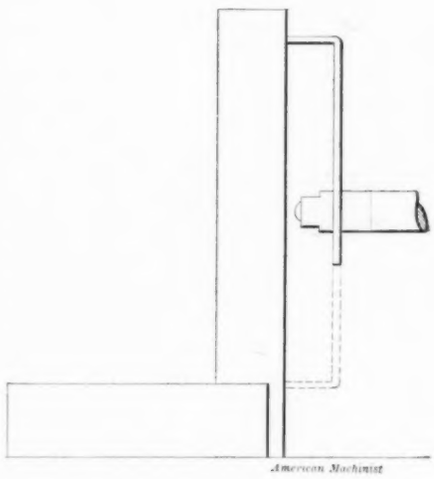


FIG. 6. SQUARING A SPINDLE.

making it square with well-defined outlines and then fitting to it a door with a neat knob. This door looked as though it were made on purpose and was part of the original design; which could not be said of the accidental hole, and though the door serves no purpose for which doors are usually provided, who will deny that the purpose which it does serve is a useful one, considering that no essential harm is done the machine by the opening.

Adjustment for Slide—Alinement of Shafts—Accurate Boring—Seeing One's Own Eye Magnified.

BY A. H. CLEAVES.

Fig. 1 illustrates a practical way of inspecting one's own eye when it is preferable to having another do so. I found the plan a very useful one a good many years since and so many have been pleased with it that I take the opportunity to publish it for general use. The ordinary jeweler's eyeglass *A* of 3- or 4-inch focus (used in the machine shop, too) is held by the thumb and forefinger against any small hand mirror *B* held by the remaining fingers of the same hand. The eye at *C*, an easily determined distance, is in a strong light, and the magnified reflection makes it easy to remove anything from it with the free hand.

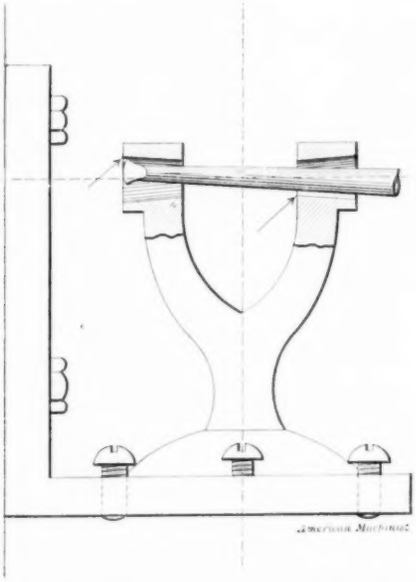


FIG. 9. BORING TAPER HOLES IN LINE AT ONE SETTING.

Figs. 2 to 6 relate to one of several items of interest met with in repairing a well-known surface grinder. The details have but little resemblance to the actual parts on the machine and are not intended to; but the point I wish to write about is this: Suppose *D* to be the casting that carries the emery-wheel spindle and which slides in the vertical side standards *F F*. The sliding fit as made before (probably a repair job) was made front and back by shimming up with paper between *D* and the back plate *E*.

After scraping *F F* to a parallel condition at these surfaces I substituted for the paper the four adjusting screws *G G G G*. In this way a space is left between *D* and *E* at *J* and the sliding fit made as follows: Clamp *D* and *E* on to *F F* with the four screws *H H H H*. Then bring the other four *G G G G* down to *D*. Loosen the first four slightly and tighten the last. The same method applies to setting the standard casting in Fig. 5. This piece had a slip of copper at *K*.

Fig. 6 illustrates an old way of testing the spindle (in this case the emery-wheel spindle). The bent rod is held between the arbor collars and shifted, as shown by the dotted lines, to the square resting on the machine base.

The man working with me on the same repair job used an impromptu boring device, Fig. 7, that may serve someone else a useful purpose. In refitting the slides of the grinder the pinion-shaft bracket hole naturally dropped out of line with the bearings in the frame. So, taking advantage of other holes in the machine, he clamped on some strips *L* and *M* for bearings for the boring bar *N*, locating the latter first in the sleeve *O*. Then using the feed screw *P* and a dog for a crank at the opposite end, he made a very nice job of it.

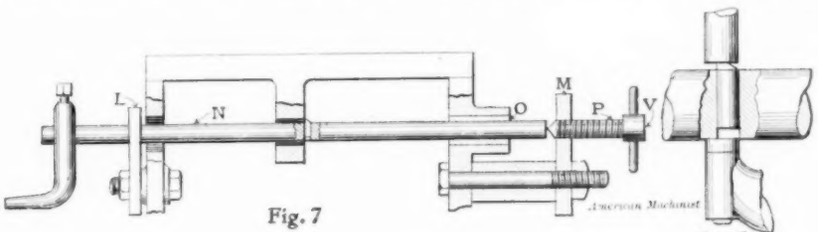


Fig. 7 Fig. 8

ATTACHING A BORING BAR AND SETTING A CUTTER.

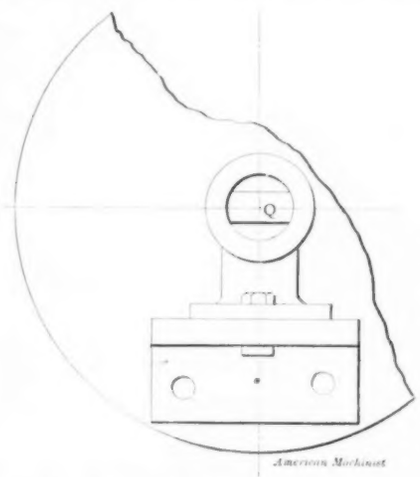


FIG. 10. CENTERING WORK FOR BORING.

Fig. 8 shows how he reset the cutter in the boring bar. If he wanted 2-1000 more taken out of the hole, he measured the cutter, as shown, and then moved it out a 1-1000 inch, measuring with a micrometer.

Fig. 9 also relates to boring. This is one of a lot of stands I saw a man boring out recently. He held the work on an inside angle plate on the lathe face-plate with four screws. Then he bored the front hole taper with the left lip of a double boring tool, running the lathe forward. Then he ran the tool through to the rear hole and bored that with the right lip of the tool, running the lathe backward. Thus the holes were sure to be in line and the same taper.

Fig. 10 is one of the regulation boring methods. The hole is drilled or roughed out in any way, and before it is mounted on the angle-plate if more convenient. Then a plug is inserted for recentering accurately. The piece is squared with the face-plate, the same trued up with an indicator and the center *Q*. The plug is then removed and the holes trued out with a light cut in any manner decided upon.

Fig. 11 shows a way of my own (of others, too, probably) of getting a hole in a piece that must come out to coincide with others through which a shaft passes. Knowing the distance required for hight, and having the shaft, place the latter on true and opposite centers, found by trying the shaft in the lathe to be used. Bring the angle plate to the exact distance from the shaft with a gage block similar to Fig. 12. I mentioned this in another article but have since used the same with a lock screw *R*, which I find makes a very convenient and reliable tool. Using this, as shown in Fig. 11 at both extremes of the angle-plate, a positive measurement for this position of the work can be obtained. The work can be located sideways with the square or by lines taken from the shaft. Remove the shaft and face-plate and center and mount the work for boring.

Something may profitably be said about assembling or mounting a machine accur-

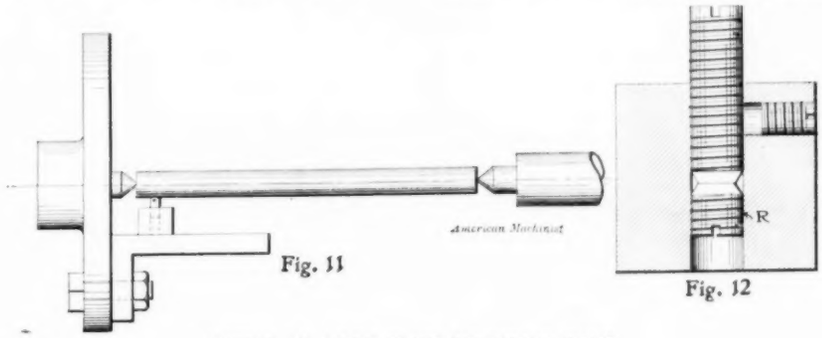


Fig. 11 Fig. 12

SETTING AN ANGLE-PLATE FOR BORING WORK.

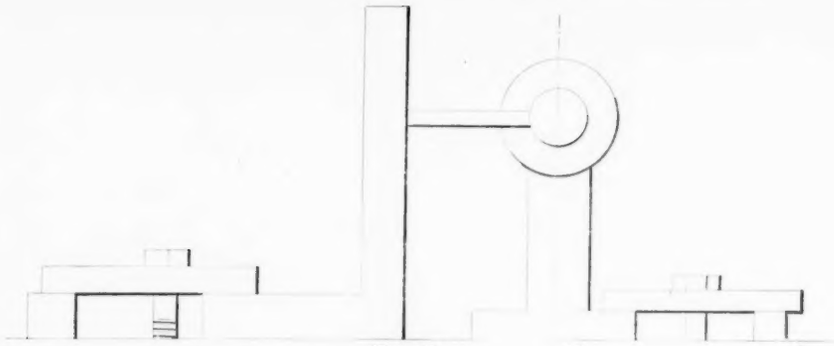


Fig. 13

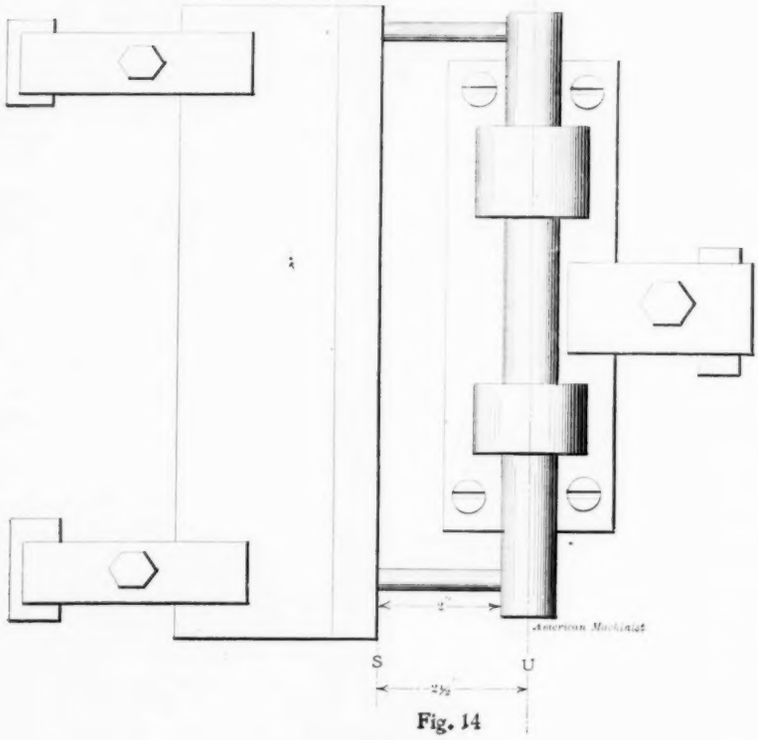


Fig. 14

SETTING SHAFTS.

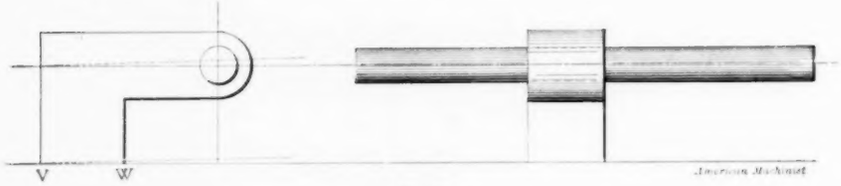


FIG. 15.

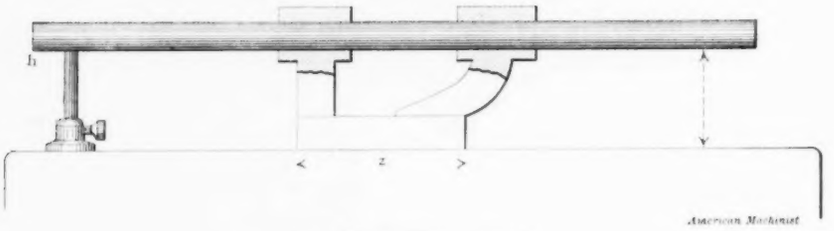


FIG. 16. ALINING A SHAFT.

ately by the use of the above and other gages. Starting with the line measurement plan, which is close enough in general, take the line *S*, Figs. 13 and 14, which is one, say, of several lines placed upon a bed-plate upon which pieces are to be fastened in relation to these lines. Bring the center line *T* on a bracket to the line *U* on the plate, the correct distance from the main line *S*. If holes are convenient on the work, utilize them in clamping, or clamp to drill press bed, and drill and tap for screws. To rectify before doweling the work if required to be close, use a parallel bar or angle-plate for high work, clamped to the bed or not. For measuring from line to shaft have the bar or angle on the line *S*, and gage between the same and the shaft in the bracket with the rod, as seen. The longer the shaft the more positive the gaging. In this way the line measure is unnecessary.

For assembling a series of shaft brackets or standards on a bed-plate, test them upon a surface plate, as shown in Fig. 16. These pieces may have been planed on the shaft, resting in V-blocks planed for the occasion, but the clamping may have distorted them so they are a long way from screwing on to the bed-plate without cramping the shaft. Take the lowest standard (and this is all that can be made of the case), bring the others to it, until they coincide with the shaft in, on the surface plate. Locate the end pieces first on the bed-plate.

An overhanging piece, like Fig. 15, is a fussy piece to correct, as a little on the base, as shown by the dotted lines, will increase at the shaft center. Rectify side deflection first, as in Fig. 16; then get the hight for the shaft hole by changing *V* or *W*.

Another method of getting shafts parallel and at proper distance apart is shown in Figs. 18 and 19. Take one of the tools for measuring inside work; use a V-piece on the slide rod. This can be set with the vernier, and is much more sensitive for measuring between shafts, horizontal or otherwise. Place the *V* on one shaft, and bring the point *X* to the same, and fasten the V-block. The other point is adjustable. This measures the exact distance or for parallels, the points being on the shaft center. In a standard like that in Fig. 16, it is hardly possible to line up by marks in the short space *Z*, and the other plan is an easy one that saves much time frequently in rehandling to put in dowel pins in heavy work.

In Figs. 20 to 22 is shown a very positive way of transferring holes in drilling where the work is overhanging, preventing a direct transfer from the piece. (See Fig. 21.) Make a punch like Fig. 20 to fill the hole in the work. (See Fig. 21.) Strike the punch with a hammer, to get the center and afterward sink it in deep enough to get the rim impression. This is much easier to locate on heavy work than a center point. Then hold this punch in the drill-press chuck (see Fig. 22) and bring the impression on the work under it. Lift up the drill spindle, slip a plate of any kind with a hole in it the size of the punch over the latter. Bring the punch down into the impression again and clamp the improvised jig piece on to the work. Then substitute the transfer drill for the punch. Drill with tapping-drill nut. Use the jig as it is clamped for tap guide, and the original piece will come to place without any doctoring. This "will not fade in the wash."

The Traveling Mechanic.

BY VER. I. NIER.

I would like to say a few words in behalf of the traveling mechanic, or, if you would choose, the tramp machinist. Having been foreman of a number of shops, with quite a varied experience in employing help, I will say that I have had the best results with the traveling class. The mechanic who has always been employed in the same shop, or in different shops in the same class of work, is unfit for work outside of that he has always been at. This man can offer no ideas or suggestions for lessening the cost of production, as he is not familiar with any other methods than those used in the one or few shops where he may have been employed. With the man who has been employed in a large number of shops, the chances are that he will take right hold of your work, and that in a great many cases he can produce it at less cost than the man that has always followed this particular line. This man may also offer the foreman valuable suggestions on doing this work to lessen the cost.

In one shop where I held a responsible position, the management offered prizes for the three best suggestions for lessening the cost of production or improving the one machine that they manufactured. The result was that the first prize of $15 was awarded to a traveling mechanic (who came from no one knows where) for a device on a press that would prevent the operator from having his fingers taken off. This proved a good attachment and increased the sale of the machines. The second prize, $10, was also won by a man of this same class for showing how to lessen the cost of certain parts, and, as in the first case, the suggestion proved a valuable one and is being used. The last prize, $5, was won by a man educated in this shop, who suggested an attachment for a machine, and I am confident it was only awarded to this man to avoid hard feelings. This idea was never heard of after the prize was awarded.

Men will sometimes say to me: "Why do you favor this class of help? By the time you get them accustomed to your work they are ready to leave for some other shop." There is where I think men employing help are wrong. A man of wide experience in various shops comes better prepared to take hold of the work, and does not require as long a time to become familiar with it as the man who has only a small amount of experience in a few shops. I admit the man does not tarry a great while, but, if the foreman is shrewd, he will gain many a valuable point in the time the man does stay. I can tell another little incident in a shop where I was foreman. There were manufactured in that shop a number of different classes of machines, and among these was one very complicated machine the work on which had always been done by one man. This had been a good arrangement, but besides him and myself there was no one in the shop able to do this work. We one day had an order for two of these machines, and while making preparations to start the work this particular man made it known that he was going to quit at noon. Well, it is needless to say I was at sea. At first I could not think of any way out of this dilemma, but it occurred to me that a day or two before a man had been at the shop inquiring for work. This man I knew to be a good mechanic, so I sent for him. I showed him the drawing, told him what I wanted and asked him if he felt confident he could do the work. He said he could, I agreed to pay him the wages he asked, and he came to work. At the end of two weeks, after neglecting my work, in the time taken to answer his questions and the time he used in trying to find out what he was doing, there had not been much progress made on the machine and I politely informed him that I would have to dispense with his services. On the morning of the third day after that a man came into the office looking for a job, and I must say he did not look at his best. I asked him a lot of questions, and I became convinced that this man was a thorough mechanic. I brought in a drawing of the machine assembled, and asked him if he thought he could do that work. He said he was positive he could. I gave him a lathe, the drawing and what tools there were for the work, and told him if there was anything he was in doubt about to let me know. He said the drawing was plain enough, but he would like to have one of the boys to cut up the stock and rough it out for him, as he thought it would lessen the cost. The work went along smoothly and the machines were finished with good workmanship, and at a cost that was satisfactory. The last time I heard of this man he was foreman in a shop that is considered one of the best. I don't mean

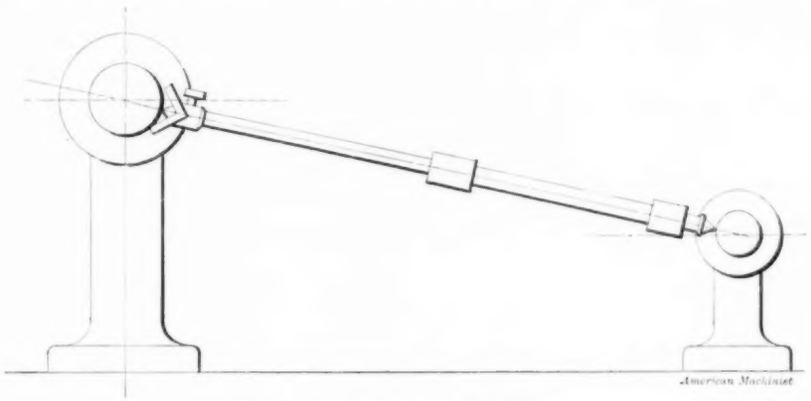


FIG. 18. SETTING SHAFTS PARALLEL.

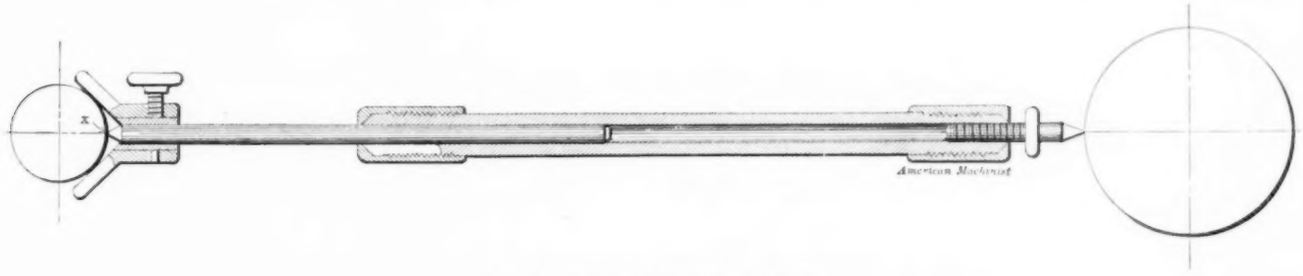


FIG. 19. GAGE FOR SETTING SHAFTS.

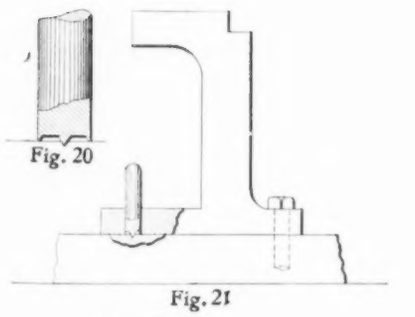


Fig. 20

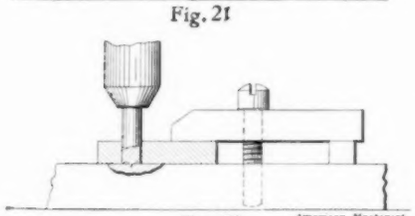


Fig. 21

Fig. 22

TRANSFERRING HOLES.

to intimate that every traveling man you see is of this description, for there are a good many just the opposite, but I think the majority belong to the first-named class.

Another thing I learned in my dealings with these men: they always asked for more wages than was being paid to the men who had always worked in the shop. At one time I was employed in a shop in Wisconsin. Among the employees of that shop was a man who had been employed there forty-one years. I said to him one day: "A——, why don't you go into some other shop to work for a change?" He said: "Why, I have been here so long I do not know how they do work in any other shop; I do not know enough to get a job in another shop." I have thought of that a great many times, and what a meaning those few words had.

A few days ago I was in a small shop where there is one toolmaker who has worked continuously for nineteen years. I, being acquainted with him, said: "S——, I see you are still in the same old place." "Yes," he said. "I would not know what to do or how to act if I went into another shop; if I had known as much as I do now I would not have stayed here all these years; but now I am fit for nothing else." The majority of men employing help at the present time give a preference to men who have a wide range of experience in various shops.

Another thing that has impressed me is the number of these traveling men that are well educated. One man in particular brought this to my notice. He came into the shop one day, his clothes well worn and dusty. He admitted he had been walking, for his money had given out. The foreman looked him over and was not very greatly impressed with his looks, but being badly in need of help he decided to try him. After he had been there a few weeks and had become acquainted, it was discovered that this man could talk four different languages and was thoroughly educated in mathematics. He worked for nearly a year in this shop, but the roving instinct got the best of him and the last time I heard of him he was in Germany.

In one shop where I was they made a great many cylinders and plungers, these being about 4 inches in diameter and 12 inches long. They were fitted air tight and after they had been fitted they were all marked to their respective places, and it was a rarity that any were interchangeable. One day there came into this shop one of these traveling mechanics. I think he said he came from down in Mexico. He was given twelve of these plungers and cylinders to finish and instructed that they must be air tight. The man commenced the work, and the progress he made was far in advance of any man who had ever done the job before, and the work was completed before the foreman was aware of it. The foreman asked him why he had not marked them for their respective places, but he said they would all fit wherever they were put, and they were found to be an exact fit and interchangeable; and all the tools this man had used to do the work were ordinary loose joint inside and outside calipers.

These are only a few of the many incidents I could relate. This style of mechanic always has my respect, as I consider him worthy of a trial in any shop.

Case Hardening for Fine Grain.

BY E. R. MARKHAM.

Many pieces of work are made of tool steel when machine steel would answer the purpose as well or better, were it not for the coarseness of the grain when the piece is case-hardened. The fine grain may be necessary to resist pressure and wear on some small part of a surface, or possibly it is to be subjected to the action of blows, and, the grain being coarse, the surface has no backing and is soon crushed in. The causes of the open grain are: First, that it is the natural condition of the stock; second, the pores are opened in the case-hardening, when the steel is absorbing carbon; the higher the heat to which the pieces are subjected the coarser the grain.

It is possible to harden machine steel in such a manner as to produce a fine grain; in fact as *fine* as that of the nicest tool steel. I would not be understood as claiming that as *good* an article can be produced for use in making fine tools; but for certain purposes cutting tools *are* made of a good grade of open hearth steel, case-hardened very deep, with fine, compact grain, which give excellent satisfaction. This is particularly the case where the cutting tooth is stubbed and strong. Cams made of low grade steel and hardened by this method will resist wear as well as though made of tool steel and hardened, and they are not as liable to flake off or break. Punch press dies for light, easy cutting metals, where there are no projections, will do very satisfactory work. Gages, whether they be snap, plug and ring or receiving, can be hardened with much less liability of going out of shape, are easier to make and will wear as long as though made of tool steel.

Many bicycle parts formerly made of the best steel are now made of machine steel, and excellent results are obtained. Such is not apt to be the case if they are simply case-hardened by the ordinary method, as the grain is too coarse to resist the peculiar action of the balls, particularly on the cones and ball seats or cups. Spindles of machines, where there is considerable tendency to wear, also a pounding or yanking motion to resist, where hardened tool steel would be liable to break and ordinary case-hardening would yield to such an extent as to make the bearings become out of round, can be treated very successfully by this method.

All that is needed is a good hardening oven, large enough to receive as many hardening boxes or pots as we may need, a plentiful supply of pots, some granulated raw bone, a good supply of granulated charcoal, a small amount of hydrocarbonated bone and some charred leather for our nicest work. We should have a plentiful supply of water in a large tank, a smaller tank arranged that we can heat it to any desired degree, and a bath of oil. Raw linseed is the best for giving a hard surface.

Pack the work the same as for ordinary case hardening, run about the same length of time and leave in the oven to cool, the same as for annealing. When it is cold, a piece can be heated in the lead pot and hardened the same as tool steel; or, if the articles are small and there are many of them, they can be repacked in the hardening pot with granulated charcoal, but not with any form of bone or leather or any carbonizing substance, as that would have a tendency to open the grain. The object of the second heat is to close the grain. The lower the hardening heat the more compact it will be. This method not only gives a close grain, but a very strong, tough surface, and, the center being soft, the piece is very strong.

When hardening tools whose office it is to cut metal, it is always best to use for a packing mixture equal parts of charred leather and charcoal. The kernels should be fine and about the same size if possible, to keep them from separating, as if there was much difference the finer would sift to the bottom. Leather gives a stronger, tougher effect than bone, it being practically free from phosphorus, while bone contains quite a percentage. The presence of phosphorus in steel makes it brittle. Yet for most purposes, where there are no cutting edges, bone is a very satisfactory carbonizing agent to use in connection with machinery steel and is much cheaper than leather.

When using either bone or leather, mix with an equal amount—by measure—of granulated charcoal. Being well mixed, the particles of charcoal keep the kernels of bone or leather from adhering to each other and forming a solid mass when heated. Then, again, the charcoal is an excellent conductor of heat, conveying it through the hardening box much more quickly than would be the case were it not used.

When hardening small pieces that do not need carbonizing more than one-thirty-second of an inch deep it is best to use No. 2 granulated raw bone; pieces that require a very deep hardened section need a coarser grade, as they must be run longer in the fire.

In case hardening bicycle cones, where it is necessary to carbonize quite deeply, it is best to pack with No. 3 bone and charcoal, equal parts, or better yet, with 2 parts raw bone, 2 parts charcoal and 1 part bone black or animal charcoal. Pack in the hardening box, as previously described in article on case hardening; run

in the oven ten hours after the box is heated through. To determine the time use test wires running down from top to bottom of box, as previously described. After the work is cold, it can be reheated in the lead pot and hardened. Drive a wedge into the axle hole of one of the cones and split it open to see how deep you have penetrated; if not deep enough, repack with fresh material and run again. But if directions given are closely followed, the results will probably be found satisfactory. The grain, as far in as the carbon has penetrated, should be as fine as that of hardened tool steel.

In hardening ball cups or seats made of machine steel, pack in a mixture of equal parts of charred leather and granulated charcoal and run six hours after the box is heated through. When cool heat in the lead pot and quench in a bath of raw linseed oil. Leather is used because the cups are generally quite thin and require toughness as well as extreme hardness.

Some articles need the ends hardened, while it is desirable to have the center soft. Take, for instance, the piece shown in Fig. 1. The surfaces of the ends marked *a* need hardening, while *B* should be soft.

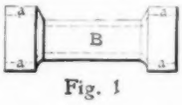


Fig. 1

Fig. 2

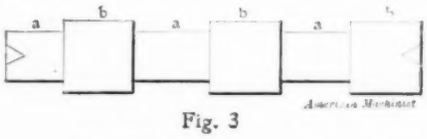


Fig. 3

CASE-HARDENING CONDITIONS.

Pack the ends, inside and out, with hydrocarbonated bone and charcoal, having previously filled the center with expended bone, cover the outside of the center with expended bone, run seven or eight hours after hot. Heat the ends separately in the lead pot, dip in a bath of lukewarm water, dipping with the heated end up, as steam would prevent the water from entering the end. If water cannot enter work it certainly cannot harden. If this piece is dipped with the heated end up the water readily enters; the ends will be found to be extremely hard and the grain will be very compact.

When it is necessary to harden the center of a piece and to leave the ends soft, it can be readily accomplished, provided the ends are smaller than the center. Take, for instance, bicycle chain studs, Fig. 2. Take wire in such lengths as can be put into the longest hardening box we have, pack with raw bone and charcoal, run three hours after box is heated through. When cool put in the screw machine and cut the ends to size. When the machine work is completed, heat in a tube and dump into water. Having cut the stock below the carbonized surface on the ends they cannot harden, while the center will be hard, the ends being soft can be riveted in the chain.

A very interesting experiment can be tried, in itself of no practical value, except that it familiarizes one with the action of carbon on the steel. Take a piece of open hearth steel, turn in the lathe as shown in Fig. 3, neck in every inch to a depth of ⅛ inch, leaving the intervening space 1 inch long. Pack the piece with raw bone and charcoal, run five or six hours after the box is heated through. When cool turn shoulders marked *b* to size of *a*, leaving *a* the same as before charging. Heat to a good red and dip in the bath; *a* will be found to be hard, while the spaces between will be soft.

I have mentioned timing the heats from that period when the box was heated through in each instance, because in most places it is customary to time from the putting of the pots into the furnaces—a very uncertain way. If the test wires mentioned in previous article are used and time is reckoned from the time the work is red, we shall get uniform results, as the work does not take carbon to amount to anything until it is red hot.

I have also mentioned open-hearth steel. This if used will give uniform results, whereas if Bessemer steel is used everything is confusion, as it runs so ununiform.

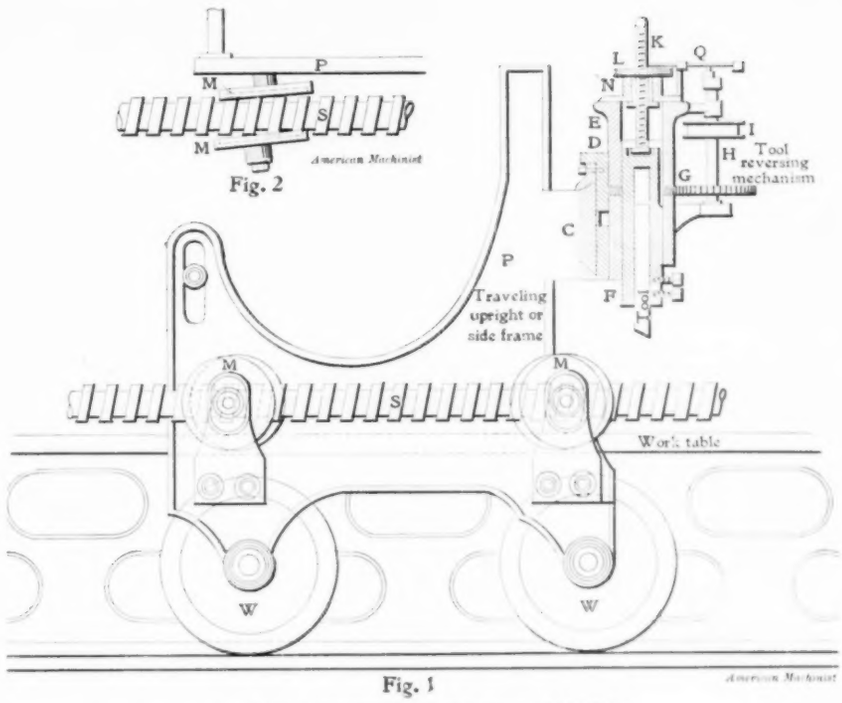


Fig. 1

AN EARLY WHITWORTH PLANING MACHINE.

Some Early Planer Inventions.

BY H. O. COOMBS.

About the end of the first third of last century there seems to have arisen considerable activity among the machine tool designers in England, which resulted in the patenting of some interesting and curious machines. Some features of these inventions of the "old masters" are substantially the same as those seen in the tools of to-day, while others are of the nature of "freaks," which have served to illustrate the truth of "the survival of the fittest" by their disappearance.

In selecting a few of these interesting early landmarks in the field of machine-tool design to describe, I have confined myself at this time to planing machines, in order to be at the same time concise and consistent. In Joseph Whitworth's planer, which he patented as early as 1835 (I am speaking now of British patents), he seems to have had in view the desirable

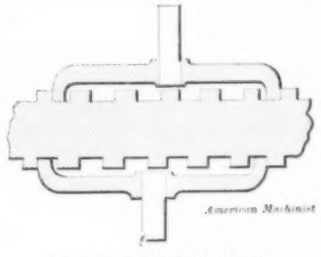


FIG. 3. DETAIL OF DRIVE.

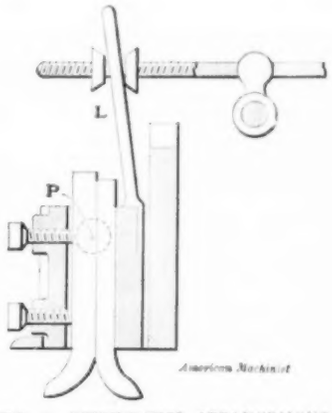


FIG. 4. DOUBLE TOOL ARRANGEMENT.

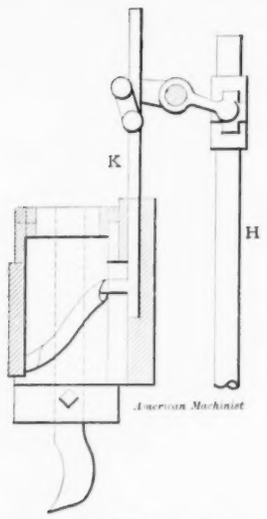


FIG. 5. TOOL REVERSE.

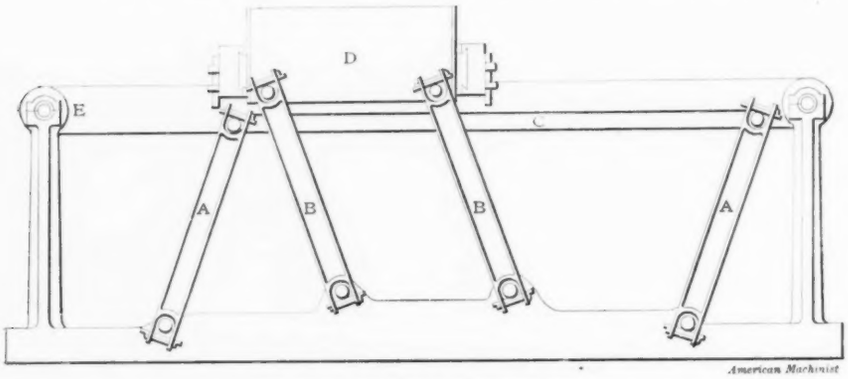


FIG. 6. A PLANER WITHOUT SLIDES.

objects of attaining for h[illegible] planer a large capacity for work as well as a capacity for large work. The most striking features of his machine are roughly illustrated in Figs. 1 and 2. It will be seen that the work table is stationary, while the uprights which carry the cross-rail are mounted on wheels which travel along rails at each side of and below the table. These uprights, which are braced and tied to each other, are moved by two large, square-threaded screws, geared to rotate in unison and to be automatically reversed. Instead of nuts for these screws to engage in, each upright carries two pairs of recessed rollers *M*, the axes of which lie obliquely, so that the thread on the screws engages the inner face of each roller on one side. Thus, two rollers on each side, one of each pair on an upright, act to move the tool carriage in each direction. In a later design, patented in 1837, the inventor improved upon his first construction, by arranging the rollers on axes at right angles to the screws, as shown in Fig. 3, so that one pair on each screw was all that was necessary, thus permitting a longer travel of the uprights.

The other feature of interest in this 1835 patent is the mechanism for reversing the tool, so that it cuts on both strokes. This would seem to be a good idea, but it must present difficulties in practice, for I do not remember ever having seen it in use. The tool is held in a socket in a cylindrical piece *F*, which can rotate and also be fed vertically in the angularly adjustable member *E*. The down feed is accomplished from the shaft *H* by the ratchet mechanism *L*, *Q* and the screw *K*. The rotative movement of *F* in *E* is also obtained from shaft *H*, by means of gears *G*. Shaft *H* receives its motion from a cord passing around pulley *I* and around pulleys at the ends of the cross-rail, one of which receives intermittent rotation from the vertical rack as usual. In the sketch the horizontal feed screw is not shown.

The double tool arrangement is shown in Fig. 4. This was patented in 1838 by John Roberts. The operation will be understood from the sketch, the head being pivoted at *P* and oscillated by the lever *L*.

Whitworth showed a modified form of tool-reversing mechanism in his 1837 patent, which is shown in outline in Fig. 5. The vertical reciprocation of the feed rod *H* is transmitted by the levers to the rod *K*, which carries a pin working in a cam groove in the tool holder, thus rotating in whenever *K* moves vertically.

A very radical departure from the typical planer, and a very unique design is that shown by an 1841 patent to Davies. In order, presumably, to avoid the necessity of long sliding surfaces, which it was probably difficult at that time to produce with accuracy, and in order to be able to plane a long surface in a comparatively short machine, he mounts the work table and the tool carriage upon rocking levers of equal length, which—to quote the inventor's own words—"in vibrating upon their centers, placed in any convenient part of the frame, pass through equal distances in arcs of the same radii and consequently preserve at all times an equal space between the tool and the table." This machine is the subject of the sketch marked Fig. 6. The levers *A* and *B*, which are pivoted to the table *C* and to the tool carriage *D*, respectively, are all actuated by an endless steel band which passes around pulleys *E* at the ends of the machine, one of said pulleys being driven by gearing which is automatically reversed. As the tool-carriage levers are attached to the upper side of the steel band and the work-table levers to the lower side, the tools, of which there are two shown, move as far in one direction as the work does in the other. The tools are arranged to clear on the back stroke.

Whitworth, in an 1839 patent, shows the cord device applied not only to the "reversal" of the tool but used also for the down feed or for the relieving of the tool. These last two operations are not simultaneously performed, however. The large wheel journaled in the frame (see Figs. 7 and 8), to which the ends of the cord are adjustably attached, is oscillated by the table. The cord passes around idlers on the cross rail and one at the

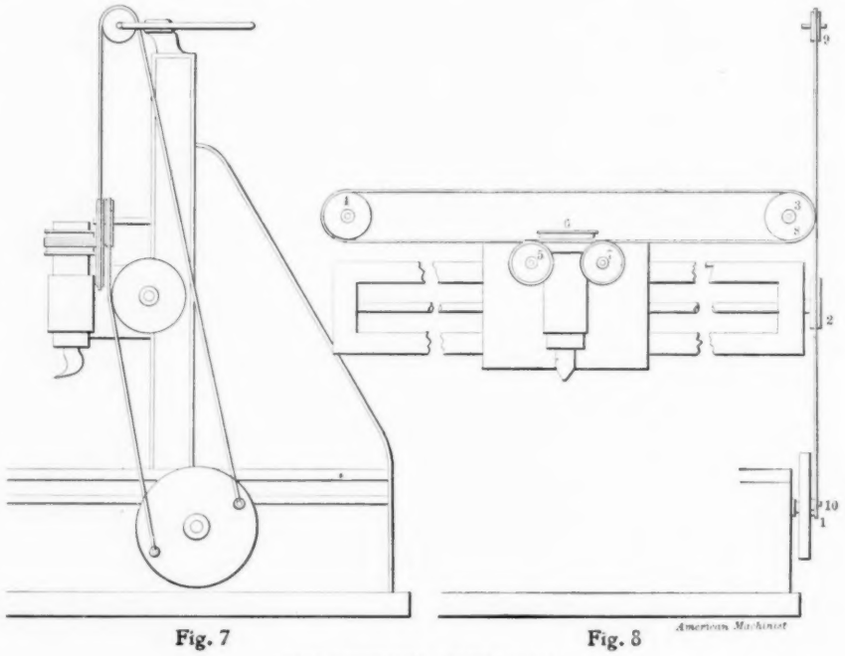


Fig. 7 Fig. 8

TOOL-REVERSING MECHANISM.

top of the uprights, arranged to take up slack, in such a way that it operates to turn the pulley mounted on the tool socket in whatever position it may be.

Letters From Practical Men.

The Proposed Standard Roller Chain.

Editor American Machinist:

With reference to the adoption of standards for roller chains referred to at page 1329, it would be well to recall the experience of the Master Car Builders' Association with regard to couplers. When the Janney coupler was designed the subject of standards was brought up and after much work by the Janney people they succeeded in having their dimensions adopted as Master Car Builders' standard. This was done without proper study

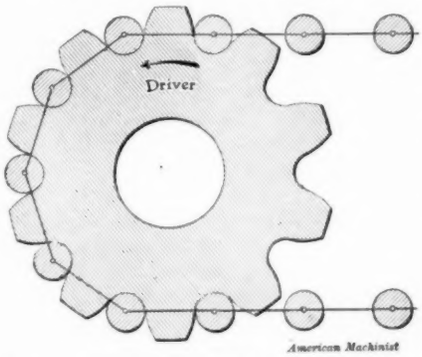


FIG. 1. FAULTY CONSTRUCTION OF WHEEL WHEN GEARING WITH A NEW CHAIN.

of the subject, with the result that to-day the knuckle is the weak point of all car couplers, but it is too late to change. I would therefore suggest that, in view of the importance of the subject, it would not be well to adopt the Whitney standards, however good, without full and free discussion. I am strongly in favor, however, of standards being adopted, but I hope that they will differ in some important particulars from those proposed.

The criticism I would make is that the rollers are too large in diameter, allowing too little tooth space. Tooth space in a chain of this type should be sufficient, not only for a tooth of ample strength, but for clearance, so that the reasonable and inevitable elongation of the chain may not render it useless long before it is worn out. This is illustrated by the drawings. In these the difference in clearance is obtained by altering the tooth, but it will be readily understood that the results are the same whether the difference in clearance is caused by the wheel tooth or the chain design. Fig. 1 shows a chain and sprocket in which the clearance is only sufficient for the tooth. This works correctly when both wheels and chain are new, but Fig. 2 shows the "climbing" that is inevitable when the chain elongates and the wheel wears.

If we now consider a properly designed

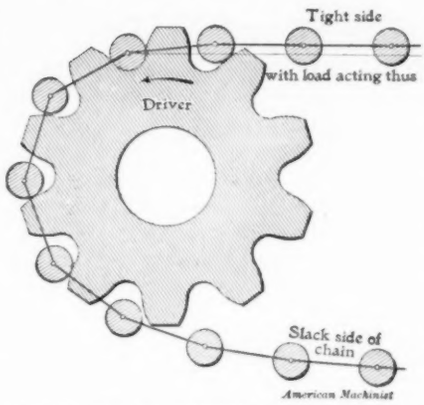


FIG. 2. FAULTY CONSTRUCTION OF WHEEL WHEN GEARING WITH A WORN CHAIN.

chain and wheel, Fig. 3, we find ample clearance, allowing the sprocket pitch to be made larger than the chain pitch; which is correct for a driver wheel, which this one is.

Fig. 4 shows this wheel gearing with a much-worn chain and illustrates how the useful life of a chain may be prolonged by allowing ample tooth space.

I am in full accord with the Whitney Manufacturing Company in their contention for large rivets, but for a different reason: I do not believe that large rivets are necessary for strength, as chains with much smaller rivets than those recommended will fail in the side bars. The importance of large rivets lies in the increased bearing surface which they offer to wear, thus decreasing the elongation and increasing the life of the chain. I am aware that it is often held that as the diameter increases so does the rubbing speed, and that one offsets the other and there is no gain by thus increasing the size of the rivet. This, however, is still a mooted point, and in any event experience has long since proved, as far as a chain is concerned, that increased pin diameter does give increased life to the chain.

A thick roller is neither necessary nor desirable. It is not desirable because it decreases the tooth space too much. It will also be seen to be unnecessary if we consider for a moment the true function

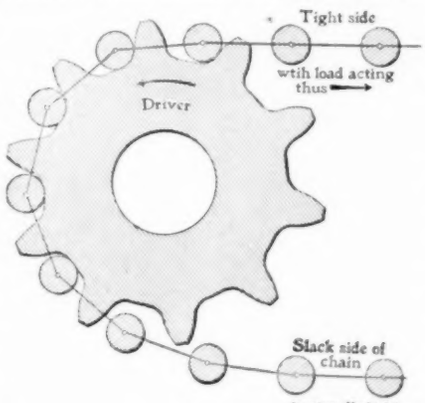


FIG. 4. CORRECT CONSTRUCTION OF A DRIVER WHEEL WHEN GEARING WITH A MUCH WORN CHAIN.

of the rollers on these chains. The mechanical advantage due to the difference in the inside and outside diameters of the roller amounts to very little; what gain there is comes from the transference of the sliding friction from the sprocket tooth to the inside of the roller, or from an exposed and often dirty surface to one protected and lubricated. This is the true function of the roller, so that it is not necessary that it be large.

But it is absolutely necessary to first determine the relation between the wear of the rivet, the bush and the roller so that all may be equally durable. The standards should aim to embrace chains which should resemble Dr. Holmes' "Wonderful One Hoss Shay," in all wearing out at once. This necessary information has not yet been collected and most assuredly

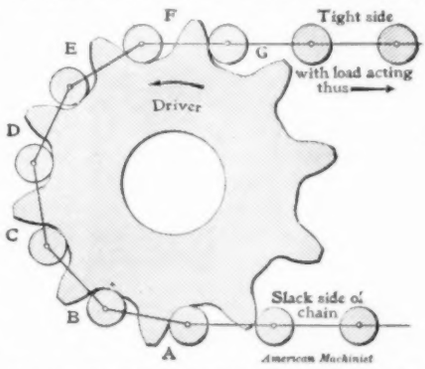


FIG. 3. CORRECT CONSTRUCTION OF A DRIVER WHEEL WHEN GEARING WITH A NEW CHAIN.

should be offered to justify the adoption of any proposed standards.

J. O. NIXON,
Link-Belt Eng. Co.
Philadelphia, Pa.

Marking Twist Drills.

Editor American Machinist:

At page 1345 is an article about marking and keeping twist drills. Allow me to say that most manufacturers of twist drills stamp the size as close to the fluted part as possible, so as to keep the stamped part out of the jaws of the chuck. Some mechanics might like to have the stamp on a flattened spot, but more would not, as the shanks of such drills would not be so apt to run true.

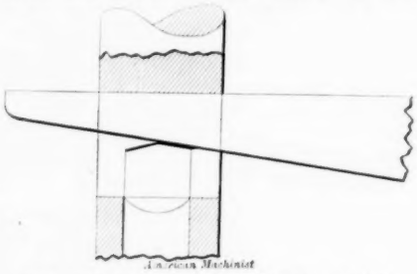
Your correspondent evidently does not use drills made to the Stubbs drill gage; for if he did he would see at once that his suggestion that drills be stamped with the numerators only would lead to endless confusion. For instance, if he told a man to drill a lot of holes No. 25, the man would be justified in using No. 25 wire size, which is .1495, instead of 25-64, which is .3906. There are a lot of things that look wrong to an outsider, but which are found to be about right when you know more about them.

J. D. COX.
Mgr. Cleveland Twist Drill Co.

The Drill, the Socket and the Drift.

Editor American Machinist:

The drill socket and drift shown among "New Things" on page 1256 seem to invite a word of remark. There is always more than one way to do a thing, and sometimes of two ways one may be a shade better than the other. The Morse Twist Drill Company has for years made drills and drifts like the sketch. It will



THE DRILL, THE SOCKET AND THE DRIFT.

be noticed that by this arrangement the bearing on the drill is overhung on each side by the bearing on the back of the drift, while in the case above referred to the bearing on the back of the drift is all on one side of the center of the socket, and even this is secured by the special beveling of the socket, while in the other case the socket is slotted straight through, as usual.

DRILL DRIFT.

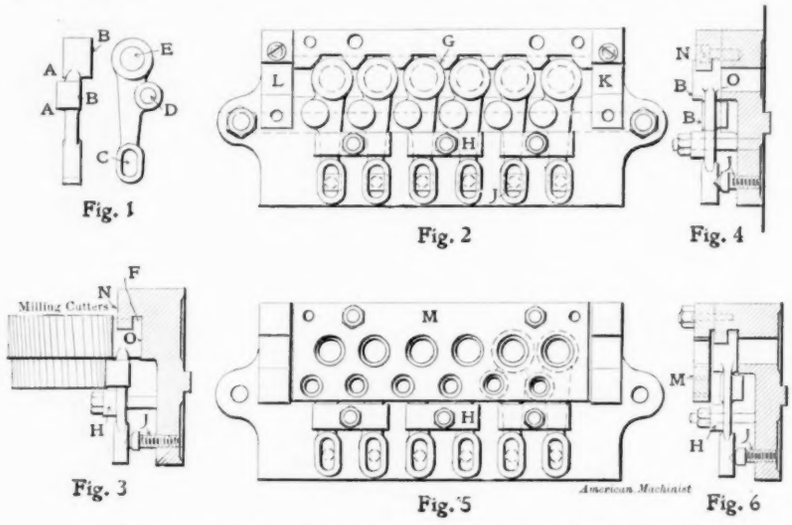
String Jigs.

Editor American Machinist:

On page 1115, Mr. W. C. Rowe writes a strong word in favor of string jigs, and gives several good reasons why they should be used wherever circumstances permit. His remarks fit in with my own ideas on this subject, and they leave little else to be said on the matter. I agree entirely with him where he points out that where extreme accuracy is required success depends as much on the condition of the machine and cutters used, and the experienced handling of the work, as on the accuracy of the jig itself. I have used string jigs for milling, slitting and drilling, and the accompanying sketches illustrate one small job where a string jig was used to advantage.

Fig. 1 shows a small slotted lever casting to be milled on surfaces *A A* and *B B*, and to be drilled with holes *D* and *E*. The slot *C* was cored in and required no machining. The jig used for milling and drilling this lever is shown in Figs. 2 to 6. It is a casting planed on the bottom, with a tongue to fit the platen of the machine. It also is machined on surfaces *N* and *O* and cut with a groove *F* from end to end, for clearance for the tool when slotting the V recesses *G*. These recesses located the boss end of the lever, the slot end *C* being carried and located by the conical head of the screws *J*. The lever castings are secured in position by clamps *H*. *K* and *L* are two hardened steel pads for setting the milling cutters to, *K* being used for surfaces *A A*, and *L* for surfaces *B B*. Fig. 3 shows the levers in position in the jig with the milling cutters at work on surfaces *A A*. Fig. 4 shows the levers in position in the jig after surfaces *A A* have been machined and ready to mill surfaces *B B*.

The same jig is used for drilling holes *E* and *D*, a cap *M* being attached to the



A STRING JIG FOR MILLING AND DRILLING SLOT LEVER CASTINGS.

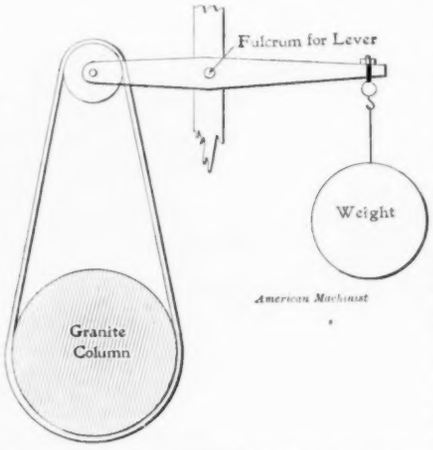
surface *N* of the jig and secured by the screws and steady pins shown, and provided with hardened steel bushes for locating the holes *E* and *D*. The conical head of screw *J*, engaging with the slot *C*, brought the two ends of the levers in correct alinement, as it was important that hole *D* should be in a definite position relative to the center line of the lever. This tool is a common every-day jig, with no elaborations, and I offer the foregoing particulars merely as another example of the general utility of string jigs.

C. PATTERSON.

Carrying the Weight of the Granite Columns in the Lathe.

Editor American Machinist:

Although I suppose that many of your readers have already heard all they want to about those granite columns for the Cathedral of St. John the Divine, I would



CARRYING THE WEIGHT OF THE GRANITE COLUMN.

like to make one addition to the already suggested methods of doing the job. I think the sketch will explain itself. If there is any danger of the rope being cut by the rough surface of the column a few layers of heavy canvas will prevent this. A few of these "rigs" might be distributed near the middle of the length of the column. I think this method is better than to turn a place on the column for a rigid support, as the stone undoubtedly changes form somewhat while being turned and the stresses set up in it by being confined to a rigid bearing might possibly tend to break it.

CORNEIL RIDDERHOF.

A Ball-Bearing Drilling Plate.

Editor American Machinist:

On page 1252 of the "American Machinist" "Drill Hand" offers a suggestion which is a very good one. The ball-bearing drilling plate would be useful in any toolroom, and I send a sketch of one which will meet all the requirements. The construction is very simple. In Fig. 2 is shown a plan and end view in which *C* and *D* are cast-iron plates ribbed on one side and flat on the other. The plain, flat face is for the balls to turn on and the ribbed faces are to allow the drill to pass through the work without drilling holes all over it. The other ribbed face goes on the drill table and gives a good bearing surface by allowing stray chips and dirt to get away, and also makes the tool considerably lighter. The plates are bored ¾ inch and counterbored 1¼ inches, and the bolt that passes through is 1 inch head and ½ inch body, which allows of a play of ¼ inch in any direction. The plate to hold the balls in position is ⅛ inch thick, and is an easy working fit on the bolt; the washers, shown in section in Fig. 2, are for holding the retaining plate in position and are a loose fit on bolt, .089 thick by 1 inch diameter, which allows the retaining plate to move freely in any direction. The bolt is 13-16 inch between head and nut, which allows of .010 play between the plates. The

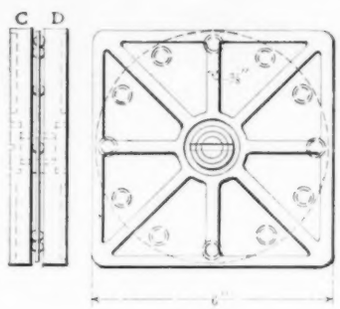


Fig. 1

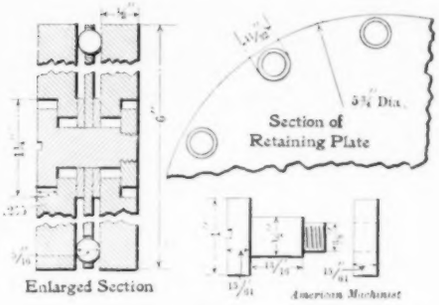


Fig. 2

A BALL-BEARING DRILLING PLATE.

balls are 5-16 inch diameter and fit in 11-32 inch holes in the retaining plate. The design of this tool allows one plate to move freely on the other, and under the least pressure will bring the work perfectly central under the drill by the free movement of the balls. The range of this tool can be changed by making the bolt and boring different sizes, and if the tool was used by such a man as "Drill Hand" it would last a lifetime. C. ALIPER.

Graduation Lines.

Editor American Machinist:

It seems to be almost the universal practice among instrument and machine tool makers to put long graduation lines on their dials and scales. Will someone please rise and explain why? If there is a reasonable excuse for the inconvenience please let us have it.

Fig. 1 shows dials from two of the best makes of milling machines. The makers spare no effort to build machines that are faultless in design, workmanship and finish. What reason they have to offer for making such confusing and unsightly graduations on the dials, we have yet to hear.

In the standard makes of scales it is quite impossible, at a glance, to select divisions with certainty. In cross-section paper where the width of lines varies the length of line is not so confusing, but on scales having the lines of equal width, and in some of nearly the same length, it requires an unreasonable amount of time and care to prevent error. There is no doubt that a greater contrast between divisions of different series will eliminate this fault. A line equal in length to the space seems a good proportion.

Lines increasing in width and depth also add much to contrast and make each series of divisions stand out clearly and distinctly (see Fig. 2). Fig. 3 illustrates another method of arriving at nearly as good results. Fig. 4 shows a series of equal divisions with long and short division lines.

The scale in Fig. 1 shows the improvement short graduation lines make over long ones. While this is not in exactly the proportion suggested, it illustrates the point.

An example of readable graduations, familiar to many, is the Coffin & Leighton protractor.

W. A. WARMAN and R. B. COCHRANE.

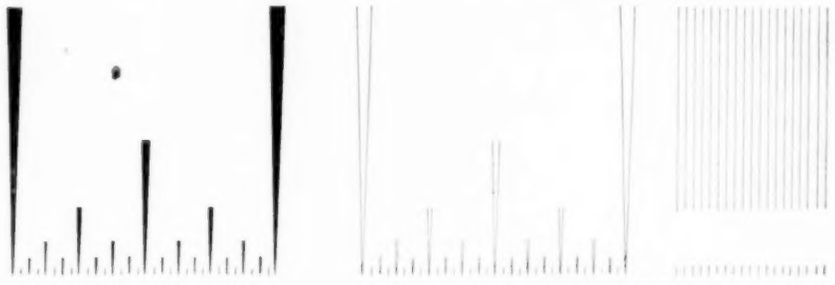


Fig. 2 Fig. 3 Fig. 4

INCREASING THE DISTINCTNESS OF GRADUATION LINES.

More About Apprentices.

Editor American Machinist:

The remarks of B. W. T. on page 1244 on the "Apprentice Problem" were to me very interesting. Other shop man-

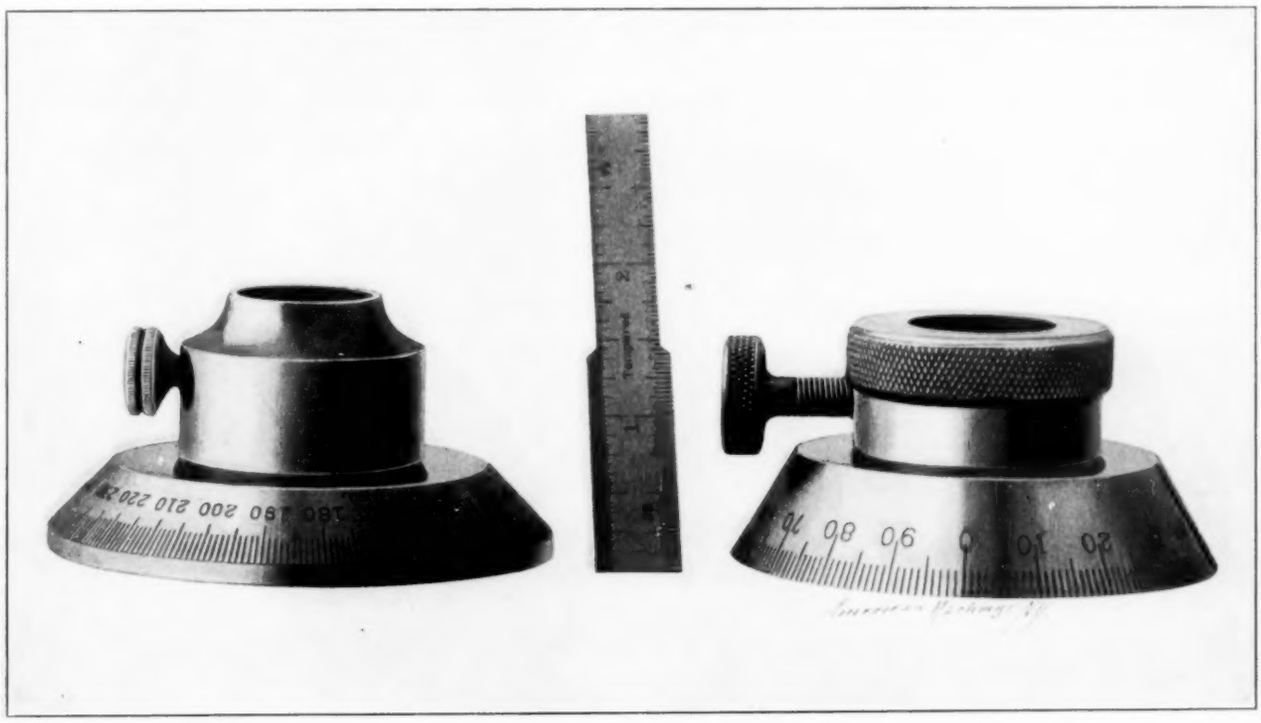


FIG. I. LONG AND SHORT GRADUATION LINES.

agers don't all get along very well with apprentices. Sometimes the fault lies with the manager and often with the apprentice. Apprentices are a problem at best. It is a case of "now you have him and now you haven't." It is, to say the least, very discouraging to the foreman to spend a lot of time and patience on a boy for two years or more, and then just as he begins to be of value have him quit, go to some other shop and give them the benefit of it.

While it is true that there are many poor workmen, it is often caused by the indifference or the faulty methods of the foreman whose duty it should be to instruct. It is doubtless true that many shops work apprentices with the view of making as much as possible out of them, and with not much interest in the boy's future. This means that he is kept on work that he has learned far longer than he ought to be. In this way he requires less of the foreman's time, and is more profitable to the concern, although it isn't justice to the boy.

I believe the only way to get boys to make mechanics of is to try them and keep trying them, retaining only those with brains and a liking for the trade. Then don't expect boys to learn the trade all alone; show them how to do work, the same thing more than once if necessary, and it probably will be. Expect them to get into mischief occasionally. Don't make work an everlasting dull grind. Modern tools perform a great many intricate and delicate operations; but, as the makers don't as yet put brains into them, the operator should possess some. Impress on him that the more he thinks about his work the better he will be able to do it, and the more he thinks the better workman he will become.

I scarcely believe that boys can earn more than they get for the first year or so, even with proper instruction. When one considers the material they waste, the fact that they each use a machine and the power to run it, that they take much of the foreman's time, that they don't work up to a man's speed, these things prevent a profit for the first year or more.

A boy living with his parents seems preferable, as he has someone to look after him outside the shop; but I would not discriminate against the boy that is trying to learn a trade and pay his own way. All honor to him; he is entitled to more credit than he usually gets.

The following method is in use in a shop which turns out mechanics that are a credit and an advertisement for that concern. The boy comes for three trial months, during which he must show a liking for the trade and some ability to learn it. For the first month he is paid nothing; for the second month he is paid 50 cents per week; for the third he is paid $1.00 per week. If a boy will work under these pay conditions he must have a desire to learn a trade. These conditions have been modified at times for boys who had to take care of themselves. If a boy has shown ability during these three months his apprenticeship begins with the fourth month, and is for six periods of six months each. Each period is to consist of 156 days actually worked; therefore the period may be six months of elapsed time or more, according to the time that has been lost, which is required to be made up before the period is complete. The pay for the first period is $2.50 per week; second, $4.00; third, $5.25; fourth, $6.75; fifth, $8.00; sixth, $9.50. These amounts have been changed to enable a boy to support himself entirely when it has been necessary; but the total amount paid during the three years remains the same. In addition to the above weekly payments, bonuses are paid as follows: A bonus of $13.00 at the end of the second period for faithful service during the first period; $13.00 at the end of the third period for faithful service during the second period, $19.50 at the end of the fourth period, $19.50 at the end of the fifth period, and at the end of the apprenticeship a bonus of $52.00 for faithful service during fifth and sixth periods. Instead of the bonus distributed as above, one of $125 may be paid at end of apprenticeship. For especially bright boys these bonuses have been increased according to ability. If a boy quits at any time he forfeits all right to any bonus.

As long as other shops will hire boys with incompleted apprentice terms some such method as this will be necessary for the foreman's protection. The boy must feel that he cannot afford to leave, and the foreman must have some assurance that he will stay. I trust this will interest some of your readers, as well as B. W. T.

J. L. GARD.

Gasoline Engine Experience.

Editor American Machinist:

I have been reading the remarks of Mr. W. A. Bright, on page 1352, about gasoline engine repairs. While his story about that rendering tank may seem to be a little doubtful to some of your readers, I do believe it, and your Mr. W. Osborne won't doubt it either.

Having the handling of a certain make of gasoline engine, I sold one to an ice-cream maker thirty miles away. Everything went lovely for about six weeks, when one day a telegram called me to his place because "the engine won't work." Upon arrival I started the engine, and it would make a couple of puffs and then stall. I investigated the gasoline pump which delivered the fluid from a small tank below to the engine, and reaching into my hip pocket I drew out my gas pipe plyers, gave the packing gland one-half turn, started the engine again, and to the surprise of the owner about the littleness of the remedy he finished his cream, and I have not heard from him since. I charged him $5 for that pleasure trip, which I certainly enjoyed.

Now one more, and it is a good one. Another ice-cream maker bought a 2½ horse-power gasoline engine, he residing in the outskirts of our town. On July 16 I installed the outfit, turning the engine over to him in first-class working order. I bought the first 5 gallons of gasoline. Two or three weeks later I was called on the telephone and heard some "Hail, Columbia" about the gasoline engine. "Come at once, get it to work, or take it out of here," were the last words I heard. I had just made up my mind that morning to fish for another customer, and, dressed in faultless white linen summer attire, I, feeling desperate, invited a friend of mine to come along, as I was out for some fun. Boarding a street car which soon brought us to the place of the trouble, his first words were, "Where have you got your tools?" As I did not have any, he at once made out a bill of damages—spoiled cream, lost ice, lost order, all had to be deducted from the balance due me on the engine. I kept quiet while he was howling. Finally I asked the question: "Say, George, did you buy any gasoline since I filled the tank when I started her?" "No," he said. "Well, here is a dime, go to the drug store and get some.' It was done. I started the engine, George kept quiet and we had a good laugh at him, and I did not get a grease spot on my suit, or I would have caught it at home.

Johnston, Pa. R. BETTERMANN.

Cutting Several Teeth at Once.

Editor American Machinist:

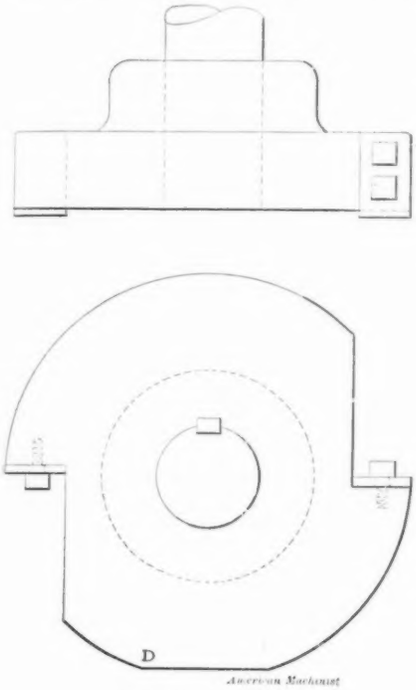
In looking over the "American Machinist" No. 49 I noticed, among other interesting items, one by Mr. Danse, page 1356, on the milling of knurls, describing the cutting of half a dozen teeth at one cut. To Mr. Danse and many others this method may be new, but it is in reality only one aplication of the duplex or multiple system of cutting gear teeth patented by Gould & Eberhardt in 1893. These multiplex cutters have been frequently advertised in the technical journals, including the "American Machinist," and have been adopted by many manufacturers of gears and machinery. By this system two to ten or more teeth, depending upon the pitch and diameter of the blank, are cut in one operation, increasing the capacity of the machine upon which they are used in proportion. A. W. JACOBI.

Boring Long Pipes.

Editor American Machinist:

Having business in the northern part of Ontario recently, and having to wait a couple of hours for train connections at a small town, I took a stroll through the place, and, seeing a regular old-time machine shop, I thought I would go in and enjoy a quiet smile or two at some of their methods. The smile is still in abeyance, for I received somewhat of a shock. They had several lengths of cast-

iron pipe 6 feet long, 10 inches inside, 12 inches outside diameter, and, being cored very roughly, they had to be bored out, and I enclose a sketch of the cutter head which was used with good effect. A piece of old 3-inch shafting with a half coupling was used, with the coupling cut out as



FOR BORING LONG PIPES.

shown. Two pieces of 1½x2-inch steel were fastened by cap-screws, as shown, and the tools and the edge of the coupling then turned to 10 inches diameter and faced, leaving the cutters projecting about ¼ inch. The other end of the shaft was flattened on one side to hold it from turning while at its work. The bottom of the coupling was planed off flat at D, I suppose to allow the cuttings to pass through. It will be noticed that the cutting was all done by the faces or ends of the cutters. One end of the pipe was held in the chuck and the other in a steady rest in the usual manner. A hole of the required size was bored in a short distance with an ordinary lathe tool first, and the bar was then brought into use. Now, while these holes did not have to be perfect, I was sufficiently interested to try the various holes which had already been done, and I must say I was surprised to find not more than about .01 inch difference in the bore of any of them. I could not help remarking inwardly that a good many of us more modern mechanics would have passed by that old length of shafting if we had been given those pipes to bore out. I may add that the depth of cut was from ⅛ to ¼ inch.

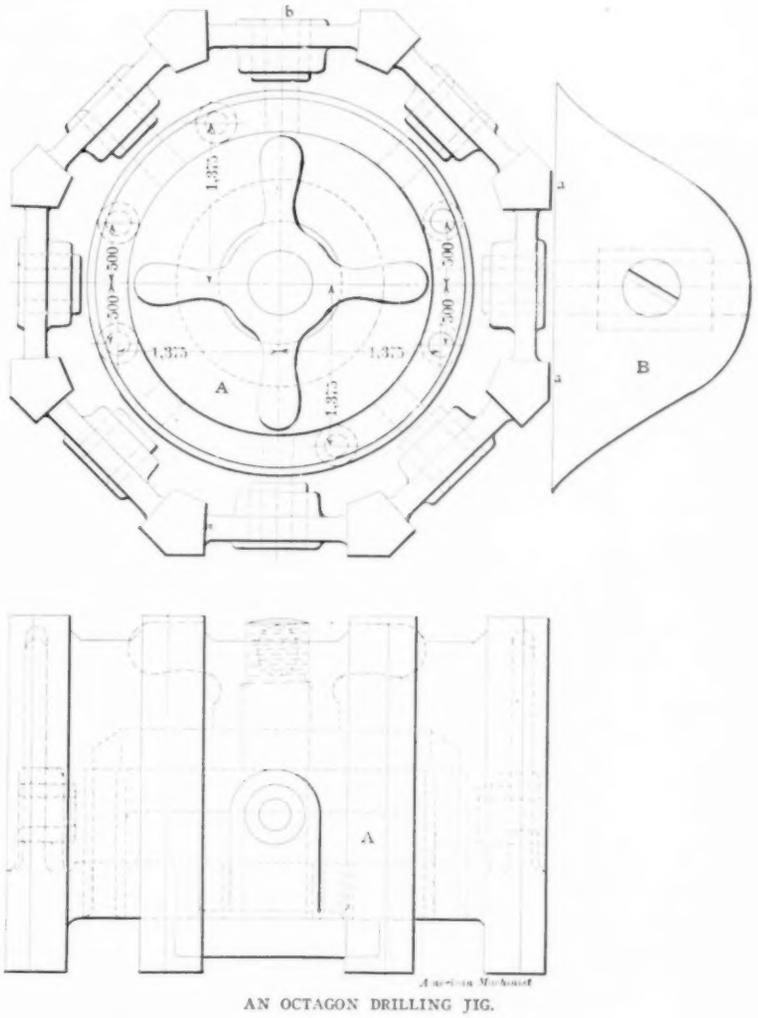
TRAVELER.

An Octagon Drilling Jig.

Editor American Machinist:

The jig here shown is for drilling eight holes around a steel ring or cylinder and also some holes lengthways of the cylinder. It is quite likely that if only the holes around the outside were to be drilled some other way of indexing would have been as advantageous; but on account of the other holes for which a jig was needed, it was thought best to use the octagon-shaped one as shown. The ring to be drilled is put on to the central locating hub *A*, and is held down by a plain washer and thumb nut. The making of the jig itself is not a simple job. Before the bushing holes are put in, the jig body must be planed and scraped to a perfect octagon, or as nearly perfect as possible, to enable us to accurately locate the holes. A practical way to space the eight holes is to fasten to the table of the milling machine an auxiliary plate with a stud securely driven into it with the end projecting above the plate somewhat higher than the holes to be bored in the jig and an easy ringing fit for the central hole in the jig, into which the locating plug for the work to be drilled is afterwards to be driven. This stud being in place on the machine table, a hole is drilled through it and then the table is set so that the center of the stud sideways is concentric with the machine spindle and the hight the holes are to be in jig preferably a little lower, .001 or .0005. This allows a little to go and come on, and to finish on the seat the work sets on. The final setting and fastening of the table for accuracy, if it does not come the first time by measuring, can be obtained by boring through the stud a few times, calipering and adjusting where necessary. The jig is then put on to the stud and fastened so that a piece of tissue paper will just be friction tight between the two feet of the jig marked *a* and *a'* and the plate *B*, which plate has a tongue that is a nice sliding fit in the slot in the table, and the edge against the jig perfectly in line with the machine spindle. We are now ready to bore the first hole at *b*. After that the plate *B* is pushed back and the work adjusted in a similar manner for the next and succeeding holes. The other holes, for drilling lengthways of the cylinder, can be bored in a lathe by setting buttons, or on the milling machine as described by "Exactor," on page 387, or by R. F. D., page 785.

The bushings are not all shown, but enough are shown to make the drawing understood. There is a spline fitted to the central bolt over which the washer slides easily, locating it so that the clearance holes in it coincide with the bushing holes. The thread extends only part way through the thumb nut to allow it to be quickly removed. The bolt, nut and



AN OCTAGON DRILLING JIG.

washer are machinery steel, case-hardened; the locating stud and bushings cast steel, hardened and ground. N. A. C.

Difficulties Encountered in Machining Conical Shells.

Editor American Machinist:

During the Spanish-American War the concern with which I was connected took a government contract to make some thirty thousand 5-inch cast-iron shells completely finished, to be shipped in specified quantities at stated times, with a forfeit of $50 a day for delay or failure. The contract was estimated on and signed by the officers of the concern, without even consulting the superintendent, which, by the way, was a regular occurrence with these people, whose office is some fifty miles from the works and who will undertake to make anything, from a flat iron to a marine engine, without taking facilities or anything else into account, and then raise Cain if the works can't work within their figures. In this case they came to the conclusion that, as they had made shells for the government during the Civil War they could still make them, for hadn't they the same tools still? and, besides, a number of new ones to back up the old ones, and then the greater skill of the employees would compensate for the greater accuracy needed now, so what more was necessary to know to make a successful bid on such a job? If the superintendent was consulted, that individual might get a swelled head and begin to think he was somebody.

Just imagine the result and the state of our feelings when, without any warning, the specifications, a copy of the contract, some blueprints, and an assortment of official fuse-plug and radius gages were dumped upon our "super's" desk with the curt order to read those over and to be sure to see that those shipments were made on time.

Our superintendent held different notions from the main guys in the office, and was not too stiff to ask opinions; therefore a pow-wow was held at which the boss patternmaker, the foundry foreman and myself were present. He stated the case, showed us the exhibits, asked our opinion, told us the difficulties he could see in the way the job was to be done and what we could expect in the line of trouble with it, and gave us our instructions and drawings, which were made and *kindly* (?) furnished us by the office.

As I was to have the tools and fittings all finished when the foundry began to send in castings, it will not be amiss to explain the method we were to follow in the shop to machine work in which .001" + or — was the limit of error for 30,000 castings.

First, these conical shells were to be gripped in a pot chuck at the pointed end, their backs faced off to a gage bottoming in the powder chamber, boring, counterboring and tapping out the fuse hole at the same setting; then screw on an arbor, center the pointed end, run it on a center, turn off about 5 inches of the length to size and turn in the dovetailed groove for the copper band. This was all to be done on screw machines and turret lathes in two handlings. From these they were to be taken to a hydraulic press, the turned part inserted into a female die and then the rest of the shell *turned* to a finish by pushing it on through. The dies were easy to make and replace and the operation actually only took six minutes per shell, including the necessary handling, doing a job equal to any lathe work I ever saw. After this the shells were taken to a grinder and their points were ground true and to their proper radius, then to the testing tubs, then to a lathe rigged up to roll in the copper and turn it to size, then on to a bench for inspection.

Now, if I remember right, the specifications alowed a variation of .010 inch in the thickness of the powder chamber walls. By this it is seen that even the government doesn't expect a cored hole to be perfectly true, and, as to boring out, though not impossible, it would make the shells too expensive. Yet our office staff, as can easily be seen by the methods to be used in machining them, figured that the core would come true o the outside in the castings, hence the hot water in which the foundry and pattern shop found themselves when they commenced to make castings and every one was rejected because the powder chamber was not just where it ought to be.

Thus it came to pass that one of the powers from the main office came to investigate why they could not cast shells and have the core true to the outside. He would have it that the patterns were off, but upon his own measurements he could not find any fault there; then it was the molder—of course it was, that was clear as mud—for if the patterns were all right it could not be anything else. So a perfect jewel of a molder from a stove foundry was sent for, but he, after a week's trial and numerous changes suggested by himself, gave it up in disgust.

Meantime, that time limit not getting any longer, the "Old Man" came up to boss things himself, and as he made himself generally disagreeable by the numerous questions, interference and continual changes, there seemed less chance than ever of something being accomplished; finally, after a particularly discouraging result of one of his schemes was announced, he went for the superintendent with blood in his eye. I happened to be present when he was relieving his mind and the conversation was something like this:

"Mr. J., something must be done at once to get castings. I'm getting heartily sick of this whole business. It seems very queer that I, the proprietor, must come up here to see why things are going wrong and then set them to rights. You are here to look after this plant, but I have yet to see a single job in which you take any apparent interest. Now, there is something rotten somewhere, and, by the Eternal, I'll find out where it is. I am paying wages equal to anybody, and, excepting the executive heads of the departments and yourself, all the employees seem to be doing their best. Now, what I want to know is, what have I got you for? You have not made a single suggestion or attempted to take this thing in hand. I've sent Mr. K. up to help you and now I've done all I could to help matters along myself; now tell me what's the matter."

"Mr. M., you want to know what I'm here for? The only reason I know or ever could find out, was to be a figurehead, to take the blame for all the mistakes made in your so-called engineering department, in which I have no say; to put up as second fiddle to your Mr. K., to obey his orders and carry out his methods. Mr. M., if you have any fault to find, you will have to commence with headquarters, for from there we get our orders, our drawings and systems, and we get them in such a way that all I can do is to obey and try and save as much as possible through managing and simplifying the systems introduced. Now, sir, let me tell you, just as long as the long-distance method of running this shop is used, you are going to lose money. So far you have lost in this our last contract, and you'll keep on losing if the thing is kept up. You know Mr. K. planned the whole thing as to casting and machining these shells, and when his method would not work he came up in person to see why; then you came yourself, and once more I get the blame. Why? Because it's impossible to carry out the system with success. And why has it not been changed? Because I have not the power."

Although the Old Man was wild it made him think, and finally he wanted to know of Mr. J. if he could straighten out the foundry tangle. Our Super. thought it over a minute, and he said he could if he was given full power and a good letting alone, also that the method of machining the shell might give trouble and he would like a change there.

The Old Man thought this over and finally he said, "I take the risk of trouble in machining them if you can get me the castings," and after some hesitation the Super. said it was a "go," on condition that he was to be given absolute power in the foundry and that Mr. K. should stay away. This the Old Man agreed to.

A draftsman was immediately set to work, under the superintendent's direction, to design new flasks, core boxes and patterns, the whole business to be of metal, machined perfectly true and interchangeable. The patterns, instead of the regulation core print, had a stem left in the base, sufficiently thick for the core of the fuse hole, the end of the stem being turned to a standard taper, the female

counterpart of which was in the base of the flask, the hole going clean through, so that no sand could settle there. The cores were molded on frames cast especially for them, having the same taper on their lower ends. The sides of the flask and cope had substantial guides, consequently nobody could part the mold except by moving the cope in a straight line and parallel to the flask. The core boxes had the same taper in which to hold the core frames, and the cores were baked in an upright position by holding them in dozen lots on frames with taper holes. The cores after baking were taken to a lathe especially fitted up for the purpose, where they were held by this same taper and ground true to diameter and length.

The method followed, which should now be perfectly clear, was to carefully wipe out the taper hole in the flask, insert the pattern, ram and flush off the sand, give the pattern a slight twist to loosen it in the taper, place the cope over and finish the mold. On the point of the pattern a piece about 1 inch diameter and 4 inches long was left. This formed the pouring hole and also a guide by which a molder could tell whether he had sprung the pattern over in ramming, this guide fitting in holes drilled into the edges of the cope and the center of the pattern. In parting the stem always came out of the lower part of mold without disturbing any part of it, and as the patterns were very smooth they came out without any trouble, leaving a nice smooth mold; no slicking up was necessary and there were none spoiled.

This system worked admirably, for if the molder was halfway careful, the core, by means of the taper guide, would always be central, and as 90 per cent. of the castings were accepted, the expensive fittings for the job more than paid the firm. It was necessary to follow some such method on account of the way the shells were to be machined, for, as I have stated, the Old Man was willing to risk trouble there.

The shells now came into us by the cartload, and we commenced operations as before described; but one shell was first to be finished clean through to be given the inspectors to bisect and test, but at the same time (orders from the Old Man) we were to keep every available man and machine going on the job for fifteen hours per day. When the sample was finished, how proud the Old Man was! Passing me he made the remark that *he* (?) would show those duffers (the inspectors) how to make shell. But those duffers had different views. They measured the diameter, length and powder chamber and pronounced them O. K. (Swelling and strutting around in the Old Man's direction.) Then they tried the fuse-plug gage. Apparently the thread was all right, but they wanted the shell split in two lengthwise. When the splitting process was over, one of the "duffers" took Prussian blue pigment for marking on the gage and rolled it in the thread. Result: Marks showed only on one side of the thread on one end and the opposite side on the other end. Then the inspector remarked to the Old Man that that would never, never do.

Yes, that would never do, and seventy odd shells already tapped out and in various stages of finish. The air suddenly became purple and blue with brimstone, when the Old Man pitched into me and wanted to know why I had not ground those taps after hardening. I ought to know that steel on tempering would contract. What had I in my head, anyway? Sawdust?

I showed him the drawings, with the draftsman's note under the taps, to "polish to dead finish before fluting and tempering"; also the legend in bold, big letters: "Stick to figures, make no changes, never do more than the indicated operations call for by finish marks," which was a particular hobby of his and appeared on all drawings and prints of the firm. I called his attention to the fact that if we were to grind taps we would have to make a grinding attachment for the lathe, and the drawings showed no provision for any such arrangement or mentioned anything about grinding except in the case of the shell point; besides, how was I to know that the pitch was to be absolutely correct, for I had not seen specifications; all I had to go by were their prints, and the job was done that way. Consequently, if things were wrong, he had better look up his draftsman who made the tracings for the shop, and not me.

He sent me for the superintendent and said: "Mr. J., kindly take full charge of this; Mr. W. will explain the difficulty. I lit on him for it, but I guess I'll have to chalk it against Mr. K., for the mistake—and I can't call it anything else—is in the drawings. It has cost me a pretty penny already, and I guess I'll have to take the matter out of his hands and place it in yours entirely. Any changes you wish to make, make them at once, and then notify me. Good day."

We made new taps and a grinding fixture, and I, thinking of the exactness necessary in the size of the thread, had one expansion tap made for a sizer to be run through by hand to compensate for wear on the machine taps.

Another shell was tapped out and split and, to my intense disgust, it showed just about the same error. This time the superintendent "got on his ear" and "lit on me" about it. He said I ought to have known better than to use expansion taps for sizing such particular work as that. The resistance of the cut would slightly twist it and in consequence it would shorten, and here I'd be with a fractional pitch. He'd show us how to make a tap. He spent all of a day in turning, cutting and grinding it himself, and when it was finished he showed me a hob tap that any mechanic would have been proud of for workmanship; but on trial, to my delight and to his amazement, it showed the same old error. He had nothing to say, but went to his office, and from there he sent me a note by the errand boy for me to find out what was wrong with that infernal lathe.

It did not take me long to decide that the error lay in the lead screw, and in order to find out I hooked the carriage on to the screw feed, using a piece of iron on the bed in such a position that it could be used as a stop in the face-plate slots. By using the same slot each time I could stop the lathe in the identical spot every time; then, by giving the lathe the same number of turns as the pitch of the lead screw, the carriage would move, if the lead screw were correct, exactly one inch. By using a vernier depth gage from the planed part of the tailstock against the carriage I was enabled to tell the error approximately, and it appeared to be nearly .002 per inch short. Doing the same stunt with every lathe in the shop I found none better but a good many worse. Now, this was a pickle none of us expected (and it didn't belong to Heinz's famous 57, either). When I told the superintendent he nearly fainted, and, thoroughly disgusted, he took the next train down to see the Old Man.

In the meantime, no instructions having been left, the job at our end at a standstill, castings piling up by the cartload, I did the only thing, I guess, that could have been done under similar circumstances. I applied a method I never heard of being used that way before or since. I wasn't absolutely certain about it, but it worked, and I suppose, by subsequent developments, it saved the Old Man about $200 in forfeits.

I took the better one of the only two lathes we had that boasted of a taper attachment, had two nuts threaded to fit the lead screw, one face of which was left flat and the other beveled off to a knife edge, the thread being bored away for a short distance at that end in order to insure a true edge. Then I had the screw removed from the lathe, carefully cleaned and examined for any burr or other inequality, the two nuts were placed upon it with the beveled edges facing one another, and the whole placed in two true V-blocks on a planer platen.

The nuts were then screwed apart until a previously tested micrometer read 5 inches from face to face, and while the necessary measuring pressure was still upon them a line was scribed the entire length of the screw and also on the beveled edges of the nuts. The idea should be clear enough now: by giving one nut exactly the number of turns for the pitch of the screw and stopping so that the lines matched, a reading taken again must show any error in the screw, providing the screw on the micrometer is correct; and if that isn't, what is? By doing this stunt inch by inch until I had to stop for want of a larger micrometer, then moving up

the stationary nut an exact number of turns, the whole screw was gone over and the errors noted.

There were some variations which I suppose were due to wear, on both the lathe the screw was made in and on itself; but by adding the whole and dividing by the number of inches tested I found an average error of .00125 inch per inch, which is only .015 inch per foot; a pretty good lead screw, considering the commercial purpose for which the lathe had been built.

Con-idering the center line of the lathe the side opposite the hypothenuse, the work the hypothenuse and the distance to move the tailstock over the base, then if $A^2 - B^2 = C^2$ and if $A = 8$ inches, the length of the tap, $B = 8$ minus the error in 8 inches $= 7.99$; then we have $8^2 - 7.99^2 = .3998^2$, and $\sqrt{.3998^2}$ = approximately .4 inch, as the distance to move over the tailstock. As to how the tailstock can be moved just that required distance was described in an article on page 872 of this year. After moving the tailstock over, set the taper attachment by the same method. It is easily perceived that the lathe will still turn parallel. As the lathe is turning parallel work at an angle to the line of the shears, you can call the tap the hypothenuse of a right triangle, and it is also easy to see that in a movement of 7.990 inches of the carriage the tool actually travels 8 inches in the oblique line due to the taper attachment.

I had several sets of taps made and in operation, and started two shifts of men on the work, running every available machine twenty hours a day. This last I did on my own responsibility. The superintendent came back four days later, informing me that he had had a precision screw cut, and had staid on the spot until it was finished and shipped by express, he expecting it that same day. When I showed him over 300 shells the inspectors had O. K.'d and accepted he was tickled, though he did not say much.

We got the first shipment out with only a few hours to spare. I did not need to cut any more taps in the above described way, for the new lead screw came on time, but the thing helped us out and may give someone else a lift in a pinch.

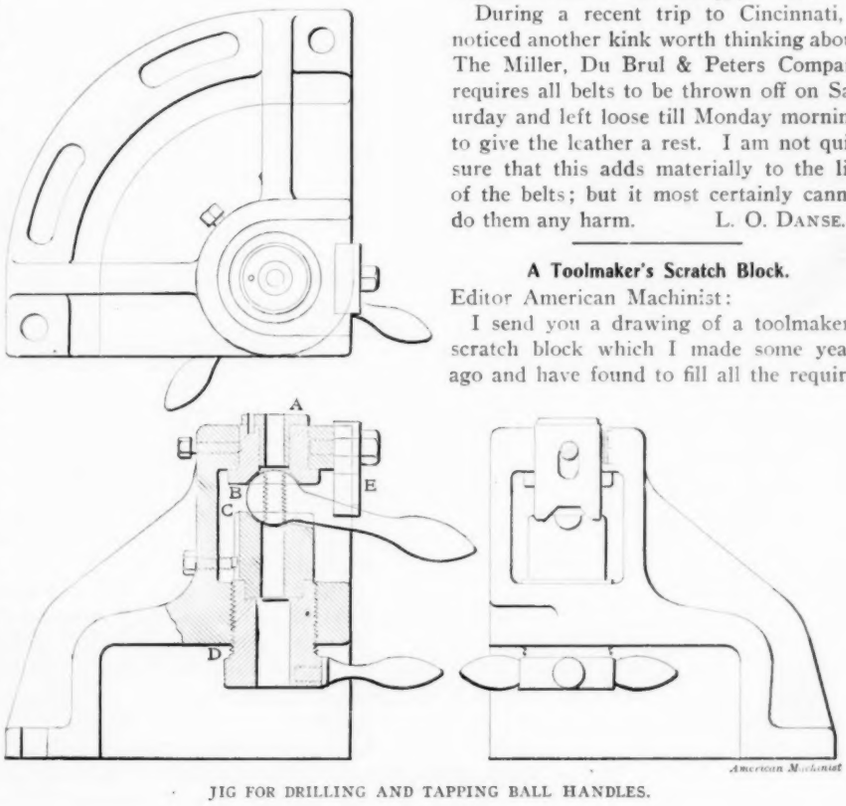
In conclusion I might state that Mr. J., our superintendent, is now the boss. The engineering department was moved to the works and placed under his complete control, also Mr. K., although still a power, has nothing to say in the works. When I was leaving things were going on nicely under the new system, and Mr. M. admitted there were some things others were better adapted for than he, and at last reports is content to sign the checks. I might also say that the firm did make money on that job, despite the severe losses at the beginning, and also that Mr. J., the foundry foreman and myself were remembered when Mr. M. got his check. L. O. W.

Jig for Drilling and Tapping a Ball.

Editor American Machinist:

Remembering the importance that the "American Machinist" attaches to the use of jigs, etc., I came across what I thought a very handy one in the up-to-date toolroom of that progressive Scotch firm of machine tool makers, John Lang & Sons, Johnstone, near Glasgow. On their machines they use the formed handle as much as possible, and seeing that so many American firms adopt the same design of handle, I thought this might interest readers of the "American Machinist." The jig here shown is for holding the ball part while it is being drilled and tapped. Difficulty was found, before the jig was made, in holding the ball satisfactorily, as the hole is needed for some machines square with the handle, and for others at an angle as shown in the sketch. *A*, the guide for the drill, is taken out when tapping. *B* and *C* are grips, with their holes beveled so as to bring the ball central for drilling. *D* is the screw, with three handles, by means of which the handle to be drilled is gripped or released. *E* is a plate which is slotted to be raised or lowered to bring the handle to whatever angle is required up to 20 degrees, a line being made on the plate and the degrees marked on the jig. As will be noticed, at one setting of the plate all handles would be drilled at the same angle, without any marking out. The upper set-screw is to keep the grip *B* in position. The lower set-screw has a tit at its end, and the grip *C* has a groove which prevents the grip from turning with the screw *D*. For different sized balls on the formed handles different grips have to be used, also for different diameters of holes guide *A* has to be made to suit. In making different grips care has to be taken that when the center line of the handle to be drilled is horizontal, the line on plate *E* is at the zero mark, or else the angles will not read correctly for all sizes. This jig takes from a ⅜-inch tapping hole, which has an inch ball, up to 1-inch tapping hole, with ball diameter 2¼ inches. The handle to be drilled is shown only in the sectional view.

Johnstone, Scotland. L. E. W.



JIG FOR DRILLING AND TAPPING BALL HANDLES.

Hanging Workmen's Coats—Preserving Drawings—Resting Belts.

Editor American Machinist:

I noticed two things at the Leland & Faulconer works which were new to me and seemed worth telling about.

The first is a simple substitute for lockers. Sticks about 4½ feet long, 1 inch thick and 3 inches wide, having a handle whittled at one end and a ½-inch hole near the other end, are hung on nails driven into the window casings. Just below the hole is an ordinary coat and hat hook. The men take down the sticks, hang their coats and hats on the hooks and then hang the whole business on the nail, where it is up out of the way and reasonably free from danger of damage. While not so nice as lockers, it is vastly better than the utter lack of conveniences of the average shop.

The other idea was for the protection of drawings while in use in the shop. The drawing in use was slipped between a sheet of binder's board and a sheet of thin, transparent celluloid, fastening the whole together with round-head paper fasteners.

During a recent trip to Cincinnati, I noticed another kink worth thinking about. The Miller, Du Brul & Peters Company requires all belts to be thrown off on Saturday and left loose till Monday morning, to give the leather a rest. I am not quite sure that this adds materially to the life of the belts; but it most certainly cannot do them any harm. L. O. DANSE.

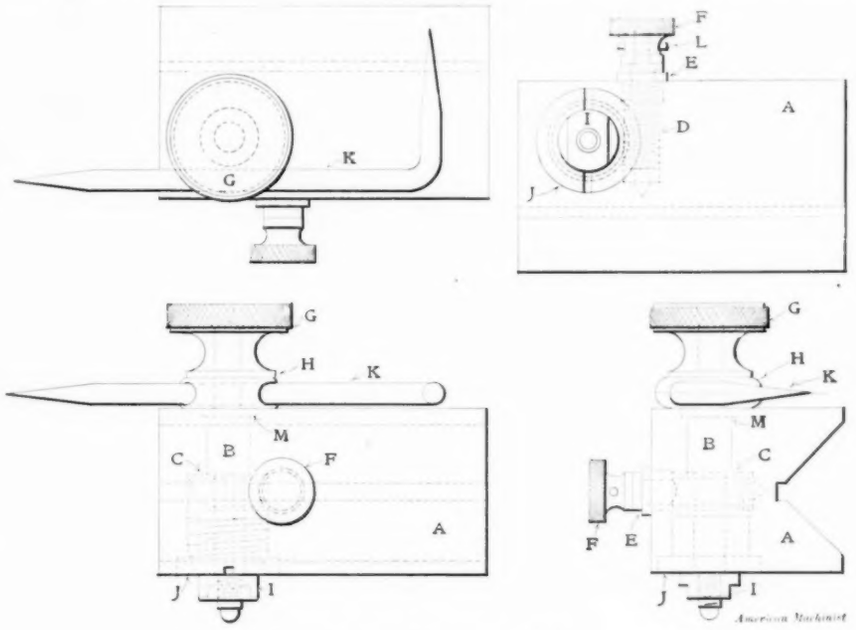
A Toolmaker's Scratch Block.

Editor American Machinist:

I send you a drawing of a toolmaker's scratch block which I made some years ago and have found to fill all the require-

ments. There are only two or three like it that I know of, and they were made by men that worked in the same shop.

A is the body or block, which is bored to receive the shaft *B*, to which is keyed the worm gear *C*, this being held against the shoulder by the sleeve *J*, which screws into the block just far enough to take a bearing on its outer shoulder and still let



A TOOLMAKER'S SCRATCH BLOCK.

the worm gear and shaft work easily without end thrust. The shaft *B* also shoulders in the block at *M*, and when the nut *I* is tightened on the sleeve *J* the gear and shaft must be free to turn without end play. *H* is a washer, or rather two half washers, drilled when together to receive the pointer *K*, the thumb nut *G* binding the pointer and at the same time bringing the back of the washer against the shoulder on *B*, which is just flush with the face of the block, but not allowing the washer to bind on the block.

The shaft, gear, washer, pointer and all, now being free to turn, after being set very near and before the pointer is tightened, may be worked as desired by the worm *D*, the end of which fits into the conical bearing *O*, and is held in position by the sleeve E, which screws into the block and against the shoulder on *D*, so that it will turn easily without any end play. The knurled head *F* is pinned by the taper cross-pin *L* to the worm. The worm wheel was made with a ¼-inch, 24-thread master tap in the lathe. Anyone wishing to make a scratch block will find this to be a very good one.

MORRIS W. LEECH.

Improving While Cheapening.

Editor American Machinist:

Fig. 1 shows a cast-iron bushing which is held fast to the machine by a cap screw passing through the hollow center. At the bottom is an oil groove and in the end a small oil hole. Up to the time when I took charge these bushings had been made of cast iron, finished by chucking, drilling the center, driving on to an arbor and forming. The oil hole was then drilled and the groove was chipped. As they came in lots of 150 about once a month, I soon made up my mind that it didn't pay to chip those grooves and drill that hole, so I had a small mill made and also a small vise to hold the bushings, and then I made up a lot like Fig. 2.

About this time the boss came along and told me that the groove on the top would not feed the oil properly and that I must arrange to get the groove on the bottom. Then I proposed the arrangement in Fig. 3. As we could form the circumferential groove without taking any more time than was required to form the piece without the groove, this design was adopted. The notch in the collar took the place of the oil hole and saved all of the drilling, while the arrangement of the grooves gave a much more satisfactory distribution of the lubricant than could be had with the original arrangement.

A 50-cent boy milled all the grooves on a hand miller in two and a half hours, while formerly the chipping took a $2.50 man a day and a half. The saving was therefore $2.50 × 1½ — 50˜ ÷ 4 = $3.75 — $0.12½ = $3.62½, or 96⅔ per cent. That is not so bad for a better job, though of course it doesn't equal the 125 per cent. saving on the coal bill mentioned by a recent correspondent. L. O. DANSE.

Detroit, Mich.

Some Observations of a Road Man—Gas Engines.

Editor American Machinist:

In writing up these experiences of mine, I am puzzled what to call them. By the office I was formally alluded to as an "erecting engineer" when I had a new engine to install; but when there was a case of trouble to be remedied I was an "expert." With the boys in the shop, however, it was simply a "road job," and the work was "setting up engines." These last had a most mistaken idea that the job was a sinecure, consisting in going round and seeing different places and setting up engines which were all done and tested. But, as a matter of fact, the outside man often has to travel all night and work all day when there is a breakdown. He has to remedy undiscovered defects, and to adjust to unexpected conditions. He has to break in new men so that they can run the engine, and, in addition to a number of other duties too numerous to mention, he frequently has his hardest task in reconciling the purchaser's notions, derived from an agent whose business it is only to sell, with the actual performance of the engine. (I am referring to gas and gasoline engines.) So he gets a varied experience.

There is one peculiarity of the internal combustion motor which gives him a good deal of employment, and that is that pretty nearly anything that can happen to one will be a sufficient excuse for it to refuse to run. If it will run at all, it is pretty certain there is not very much the matter. In this it is quite different from a steam engine.

There are two things particularly to be looked out for in taking care of a gas or gasoline engine, and failure to do so probably causes more trouble than all the other numerous possible sources put together. These are a good spark and tight valves. I remember especially an engine in a small printing office. They wired for a man, as the engine wouldn't run, and they couldn't

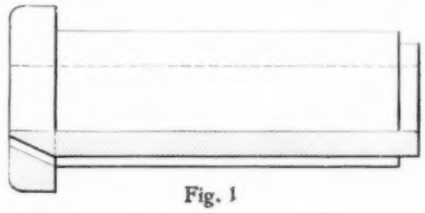


Fig. 1

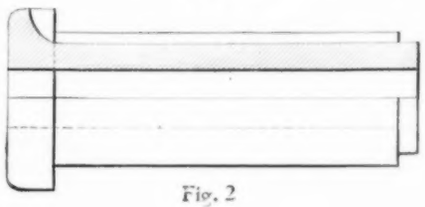


Fig. 2

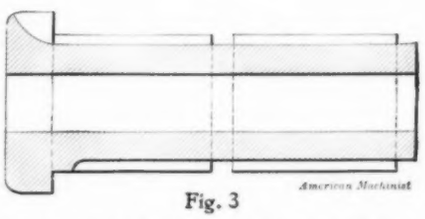


Fig. 3

MAKING THE BUSHING CHEAPER AND BETTER.

get the paper out. I was sent. I tried the compression. It was good. So was the battery. I asked if they had done any "monkeying" with it. This is generally a useless question, because, in nine cases out of ten, after having changed everything adjustable, in hopes of striking the combination, they will deny having done anything. This case was no exception. No one had done anything to it. When their attention was called to the igniter snapping in the middle of the stroke, instead of just before the beginning, the engineer suddenly remembered that they had changed that last night when it wouldn't go. In this case the igniter points needed a little cleaning and that was all. Of course, they had to be timed again. After I got through I called the proprietor aside and told him I would like to go over the engine with him. He answered, "Tell the man in charge." "But he may leave you," I told him. This is precisely what did occur, and some time after I had to go there again on the same errand, because only that one man had profited by the previous experience.

Another time I was sent out on an engine which would not run regularly. It would run all right for a little while, and then there would be a loud explosion in the base from which the air pipe led. A little examination showed that a roller interposed between the exhaust valve stem and the cam which operated it had worn a flat spot on it, and when this came around the valve did not open properly. Hence the engine did not exhaust well, and sufficient of the old charge remained in the cylinder to ignite the incoming charge; and, as the air valve would of course be open while this was happening, the new mixture on igniting would discharge into the base through the air pipe. When showed the flat spot they "had not noticed that."

One of the unusual cases was in the "Gas Belt." They had run the engine successfully about five months before in the summer. Since then it had been idle until a purchaser had been found for it. But now they had a chance to sell it, why, the confounded thing wouldn't run. The men in the shop greeted me with a cheerful grin when I called for volunteers to turn it over, and gave me to understand it was not for lack of trying that they had failed. It was discovered that the sole reason for the failure of their efforts lay in an exhaust pipe solidly frozen up. They had led it into an iron box in the ground in order to muffle the sound and this was filled with ice.

One might go on indefinitely, for this work lends itself to anecdote; but it was my intention in writing this merely to show the joys and woes of the outside man in the particular line which I have tried. The outside man is after all only one of the chain of men, beginning with the designer and extending through pattern shop, blacksmith shop, foundry, and machine shop, and hence his career is a legitimate subject for your consideration. T. A. B.

English Lathes.

Editor American Machinist:

The letter of that banished Englishman in South America reminds me of an equally serious complaint which I heard not long ago. I was talking recently to the foreman of the turning shop of a big engineering firm in this country (Spain) and we stood for a few minutes watching a lathe about 30 feet long and 60 inches swing. Said the Spaniard to me: "Now, that's an English lathe and it's not much good. The saddle is so long in front of the tool post that you can't get close enough up to the head for very small work, and has too much play in it for very fine work. When you put a full-size piece in the centers, you've got to have the slide-rest so far out that there isn't so much room to pass along the front of the machine, and the slide-rest being so high kicks if you try a very heavy cut." And he looked very serious and added, "Yet it cost a lot of money, too, did that lathe."

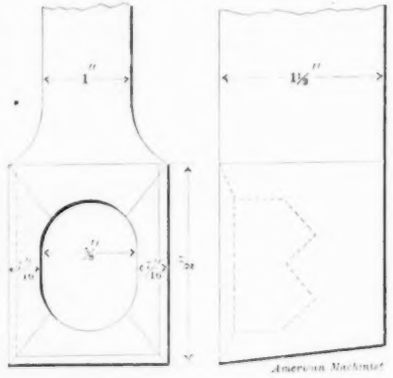


FIG. 1. TOOL FOR PLANING TINNED CROSSHEADS.

I had seen that lathe a good few times before and never saw it idle. It was generally turning up something pretty long and pretty thick; and even while we looked at it the chips were rolling off in pretty good style. Also I had seen my foreman friend before that day. He was a dry old chap of close about seventy years old, and as I had begun to know some of his little ways I only remarked that the lathe seemed to be doing fairly well for one that had passed its first youth. So he continued dryly: "Now, those hexagon turret lathes that came out from England this spring turn out fully ten times as many pieces per day as this can, and so does that automatic we bought from Paris Exhibition last year, and yet this lathe was bought from the Exhibition, too, and it's very near worn out already." "Oh," said I, "you shouldn't be despondent about it; there's life in the old dog yet. At which exhibition was it bought?" And he lit his cigarette thoughtfully and replied: "Well, yes, it's good enough perhaps for those big columns. But it came from the exhibition right enough. Cost a lot of money, too, I remember. *London Exhibition, it was, in* 1851," and he walked slowly off and looked back at me from behind a pillar about five yards away and chuckled, "but it's English, and it's no good for fine work."

J. H. BALL.

Barcelona.

Tool for Planing Tinned Crossheads.

Editor American Machinist:

Fig. 1 shows a tool used for planing the tinned surfaces of crossheads, Fig. 2, for compound locomotives. The crosshead is shown in its normal position on the engine, but in planing it is laid on its side, so that the one tool will plane the surfaces *a* with the bottom edge of it and the surfaces *b* with the sides of the tool. The front of the tool is beveled in to give a sharp cut both at the sides and the bottom. The middle of the cutting front is drilled in to a depth of about ¾ inch, which saves the tool from cracking in hardening. The tin must be well united to the metal of the crosshead to enable it to stand the heavy cuts taken by this tool.

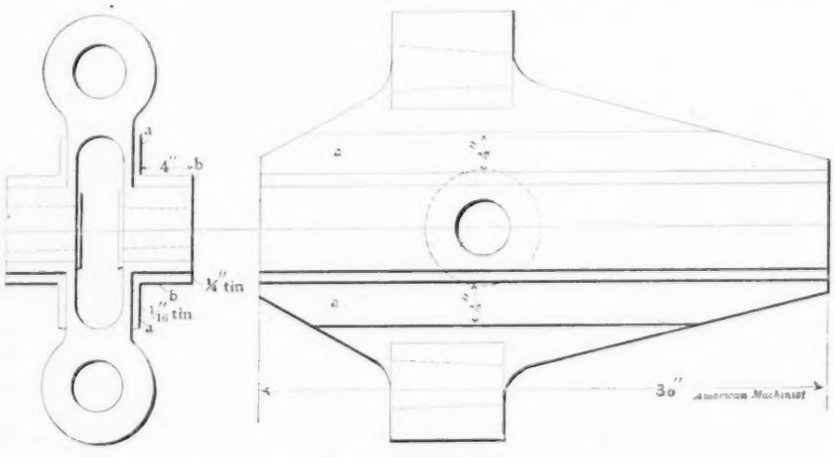


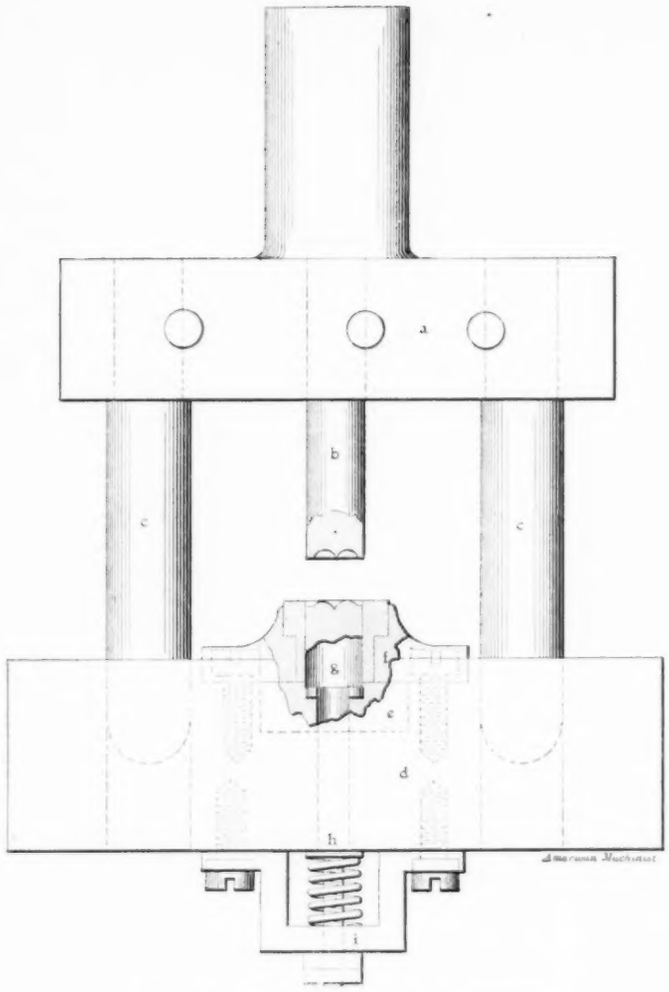
FIG. 2. TINNED CROSSHEADS FOR COMPOUND LOCOMOTIVES.

J. F. W.

A Blanking and Forming Die.

Editor American Machinist:

The compound die, of which I send sketch, was made to punch and form at one operation, buttons used on the heads of nails for pressed steel ceilings and side



COMPOUND DIE FOR NAIL HEADS OR BUTTONS.

walls. It has been in use for over a year, turning out hundreds of thousands with a very small expenditure for repairs.

It consists of the punch holder *a*, of cast iron, machined in the usual manner; the punch *b*, of hardened tool steel, driven into the holder and fastened by the taper pin half in punch and half in holder, and the two guides *c c*, which also are driven into the holder and secured in the same manner.

The die consists of the cast-iron block *d* planed to fit the shoe of the press, and bored for the bushing or base-plate *e*, of tool steel, and the mount, or die-holder proper, of machinery steel, a light driving fit in the die block and held in place by the screws as shown. Into this mount is driven the cutting die. The base-plate is bored possibly .005 inch smaller than the plunger or former *g*. It is then hardened and held in the chuck of universal grinder or bench lathe, and the hole is ground out to fit the plunger, which has previously been accurately ground. It is then swung upon a solder chuck, which has a projection to fit the hole; the opposite side is trued up and the outside is ground to drive closely into the casting. The former, besides being a close fit in the base-plate, has a bearing through the casting and is turned smaller at *h* to form a shoulder for the collar, which forms a bearing for the spring, the tension of which is adjusted by the two lock nuts and the yoke *i*.

In operation, the stock is passed over the die between the guide pins (not shown), the press is tripped, the punch travels downward, blanking out the button and continuing its stroke until it strikes the former, carrying it against the base-plate and forming it to the shape shown. Releasing the spring throws the button out of the die and through the blanked hole in the stock, which brushes it off as it is pushed forward for the next. The press runs 125 strokes per minute, and allowing for stoppage, turns out about 6,500 finished buttons an hour. Query: Do compound dies pay?

W. E. CALLAGHAN.

A Milling Jig.

Editor American Machinist:

The sketch shows a piece of work, with milling machine vise jaws for taking a cut at *A* and also for slotting the tapped hole preparatory to drilling. The hole at *B* is already in, and the sides of that hub are machined to thickness. The piece to be operated on is put on to the locating stud *b*, and the vise is tightened, holding the work so that the other end will be in contact with stop *a*. The spring pin *c* is then tightened, and we are ready to take our milling cut with an end mill.

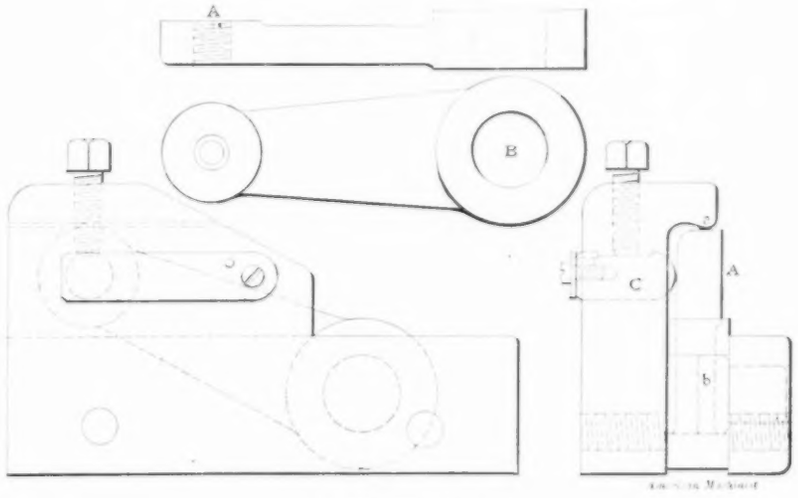
It will seem to some that time is lost by using an end mill on cuts of this kind, but a coarse feed can be used and a nice surface is produced, and the one operating the machine on this cut will quite likely be running another machine on something else. To spot the second hole, the work is reversed in the vise, and the spotting is done on the rough side, so that the work can afterwards be laid on the machined side to be drilled in an upright.

N. A. C.

Splitting Up a Foreman.

Editor American Machinist:

It must have been hypnotism. I can't account for it in any other way. It happened at the recent meeting in New York of the American Society of Mechanical Engineers. I got a chance to attend one of the sessions of that body, but, unfortunately, I was not there at the beginning of it, and I suppose it was for that reason that I was not put completely under the



A MILLING JIG.

spell. When I came in, near the middle of the session, the hypnotist had the crowd like putty under his touch, and by his smoothly plastering talk he was molding their ideas in a, to me, most surprising fashion. The topic under discussion had to do with the methods to be adopted for getting the tools of a shop and the men who operate them to work together with the highest efficiency; and the system advocated, of planning the job in detail, of laying out in advance every movement to be made, the shape and the setting of the tools, the speeds and feeds and all the rest of it, so that the time should be reduced to the possible minimum, I have nothing to say against any of that. When it comes to deciding upon the means by which some of these things are to be accomplished there is at once chance for differences of opinion—if you don't get hypnotized. Well, as I came in the veteran hypnotist was telling his hearers that it is in these days impossible to get competent foremen. He said that you can't get them for love or money. I never heard of love being tried for securing foremen, and as to money my impression is that not enough money has been tried to find out whether that would do it or not. I know well enough that good foremen are scarce, but I believe it is for the simple reason that one who is capable of being a good foreman is capable of several other things, and some of these other things promise more money, and so he gets out, and is getting out all the while. Offer foremen more money—those who are worth it—and they will not be so scarce.

The hypnotist put it down as an undebatable proposition, that while you must have foremen you can't get them. At the same time he stated that he could at short notice supply foremen *ad libitum*. His scheme, in brief, was to take from half a dozen to a dozen men and make one foreman of the lot. It would seem that when you have paid the hypnotist and the six sixths or the twelve twelfths of a foreman you have paid out enough to have secured at least two competent, all-around foremen. An assumption which also the hypnotist seemed to carry along and work into the minds of his subjects was that no workman knows anything or, in his scheme, is to be expected or even permitted to know anything. Every operation is to be directed by a boss. Having to do merely with the cutting and shaping of metal as done by the various tools of the machine shop, there must of course be a tool boss. He must select, or direct and approve of the selection, of the proper cutting tool for each operation, more particularly, see to the adjustment of the tool according to the previously planned scheme of operations. Only this and nothing more must this boss know or do. Then after this boss must come the speed boss, who would have nothing to do with anything except to see that the right speeds and feeds were used on the several jobs over which he had supervision. Then the gang boss would get the work ready for each machine, seeing that there was always work ahead to be immediately taken hold of on the completion of the previous job, with drawings, jigs, gages and whatever special devices or facilities were provided. This boss would have nothing to do with the actual doing of any of the work. Another boss would be the inspector, who would, at the other end, have to do with the correctness or quality of the work produced, but he also would have nothing to do with the doing of any of the work. Another boss would have to do with time only. He would keep records of the time of each job and operation and see that schedule time was made, or make remarks about it if not made. Another boss, or in this case, if the works were of much extent, a set of men, would decide how everything was to be done to the minutest detail and make out instruction cards to be followed all through the job. There should be another boss who should have to do only with the discipline of the shop. As the hypnotist explained it, if any workman should be at all anxious to have any one of the fractions of a boss to go to a specified place, and should tell him so, it would be the duty of the discipline boss to come around and ascertain whether the man actually did insist that the fraction should go to the place suggested. I can't help thinking that this discipline fraction of a boss would have as much of a job on his hands as any of them, especially when the hypnotism lost its hold, as it is apt to do after the hypnotist has gone to other fields, and sometimes before that.

There can be not the slightest doubt that the hypnotist, whom I have not here consciously misrepresented, believed absolutely in his scheme as he told it. He assured his hearers that it had actually been put in practice, with eminent success. The rules of the society allow a speaker ten minutes, but the hypnotist talked a half an hour or more, when the president recovered sufficiently to suggest that others might be glad to have a chance to say something, and the hypnotist sat down, while the audience applauded, with the evident belief that he had contributed the most valuable morsel of the meeting. I certainly believe that there must have been some hypnotism about it. I never knew of so many bosses being employed, but I have many times heard men complain in the shop of "having too many bosses," and that complaint is a more frequent reason for men's throwing up jobs otherwise satisfactory than any other that I know of. Splitting up the foreman is not the suggestion of an experienced and long-successful shop manager, and I don't believe it is ever to be more than temporarily the winning way.

TECUMSEH SWIFT.

Filing Crank Pins.

Editor American Machinist:

The letter on the above subject on page 1358 will give foreigners (for you have an extensive European circulation, I believe) a poor opinion of American handicraftsmanship, and there are many abroad who, ignorant of the facts, are only too ready to believe anything disparaging concerning the "States." I merely write to express an opinion that the case quoted was an exceptional one in the time and trouble bestowed thereon. I fully appreciate your correspondent's motive in writing. When an engineer has done a job in what he deems a better or more expedient manner than hitherto he does a good deed in giving his fellows an account thereof; but, really, in the case in question unnecessary pains were taken, the result being that a half-hour's job took over nine hours, and I say this advisedly. I have filed up pins under very awkward conditions. It's bad enough when on a stationary undertype engine, but then you *can* pinch her around. It's worse in locomotive work, where the pair of wheels wanted are in the middle of a group and cannot be moved. When (as in my case) they were all crank axles, with webs 12 inches wide and only 48 inches apart, and the cranks were liable to be in "any old" position, the job was not a nice one, as part of the filing sometimes had to be done lying on one's back. Even then I never took more than about an hour on a pin, and they were from 7½ to 8 inches diameter at that.

First file the pin round (and parallel), working to your calipers, and then go over it with a smoother file. When the pin is scored (and you wouldn't be filing it up if it wasn't) the marks themselves constitute a guide, although as the pin is sure to be more or less oval (according to material and length of service) the marks on about half the pin will have to be taken right out; also the pin, if very old, may be taper, in which case it is good practice while about the job to make it parallel. Your calipers will tell you broadly how the diameters are shaping, and, for the rest, you depend on a good, even sweep of the file, a matter of practice only. Then wrap a strip of emery cloth around the pin and take two or three turns of a piece of clothes-line; get a helper on to the other end of it, and pull back and forth and work laterally on the pin at the same time, with as long a stroke as convenient. About three minutes of this treatment will suffice. As to the four hours' filing mentioned, with the use of the templets and marking, it's a wonder they didn't go a step farther and use the scraper. Also the hour's work with the caliper was absolutely time wasted, for the glossy appearance mentioned is by no means the essential it is thought to be.

Your correspondent may think I am exaggerating matters; but I would remark that in roundhouse work you have to deal with these jobs pretty often, and in limited

time, too. A main pin runs hot, say: Babbitt thrown out, oil hole blocked, and brass and pin soon cut, more or less badly. By the time the engine reaches the pit there may be only three-quarters of an hour left before taking her return train out, and you have to go under (I refer to inside connected engines, with which my experience has always been—worse luck) and disconnect; while the brass is being re-metaled, file up the pin. Then clear out the oil hole, file and scrape the brass, refit the pin, line up (if time) and recouple. And perhaps other engines have come up, so that you can't pinch yours around as you progress with your pin-filing.

I have done this job many times, and I guess that marine engineers, with their huge pins and journals and only about three hours' stay in wayside ports, could tell still more harowing tales. I would merely add that it is only after dealing with many journals that one gets to know how much he can leave *undone* in the matter of finish.

By the way, if crank-pins were always made of wrought iron and case hardened, very little oval wear, if any, would be experienced, and the pin would suffer but little when it got hot, the brass suffering all the abrasion. H. ROLFE.

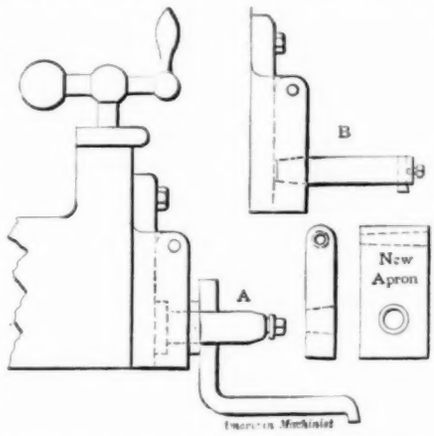
Wilkinsburg, Pa.

Interchangeable Racks and Pinions.

Editor American Machinist:

The enclosed sketch illustrates a method of calipering racks and pinions, by which they may be made interchangeable. The gage block *B*, a side view of which is shown at *E*, is made with an angle of 29 degrees, and is used in connection with a master rack and pinion which are known to be right. It may be readily seen by the sketch that if, in cutting the pinions, they are made to caliper the same at *A* as the master pinion, they will be all alike, regardless of any variation in the diameter of the blanks. Care should be taken to have the measuring points of the calipers on the center line *C—D*, which, in the case illustrated, passes through the center of a tooth and that of the opposite space, as the pinion shown has an odd number of teeth. In the case of a pinion having an even number of teeth, it is obvious that the line would pass through opposite spaces. The sketch plainly shows the manner of measuring the rack. By following this method the depth of the rack seat may be machined to gage, and when the parts are assembled they will interchange, thus obviating the necessity of waiting until the gear cutting is finished and then fitting in the racks by the old "cut and try" plan and numbering each piece to its own respective place.

Cleveland, O. E. E. WINSHIP.

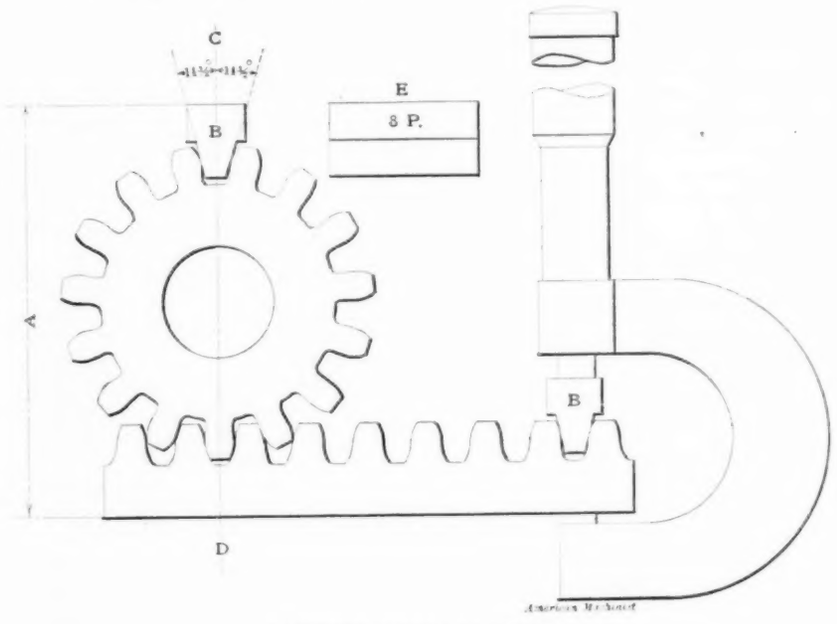


TOOL FOR INTERNAL WORK ON THE SHAPER.

A Tool for the Shaper for Internal Work.

Editor American Machinist:

I have seen many devices in the "American Machinist" for internal work on the shaper, but have never observed any just quite so neat as the one Abe. Russell brought out in the Pushfinger shops. To realize the advantage of the scheme it is only neces-ary to glance at the earlier and the later devices side by side. We all recognize the makeshift *A*, where the tool-post is *always* in the way. To make the change to *B* it is only necessary to make a new apron, fitted to swing on the taper pin the same as the one for the tool-post. These can then be instantly changed one for the other by simply driving out the taper pin. This apron is shown with a taper hole to receive the tool bar. The bar itself may be of tool steel or it may have inserted cutters as shown. This plan is in use in a large factory near New York, and gives good results. It is used for planing out dies. ISAAC MORGAN.



CALIPERING RACKS AND PINIONS.

Faulty Tools on Good Machines.

Editor American Machinist:

Does a builder of machinery do justice to his product when he equips it with poorly designed tools, or with tools that never were designed at all? It is not the machine that pays the dividends, but the cutting edges with which it is supplied, and if they are poorly designed they prove a serious handicap. I have had a number of unusually painful instances brought to my notice recently, and some of them are almost beyond belief. "Steeple Jack," who paints our smokestack twice a year, I am sure could design a set of tools better than many sent out by some prominent builders. Some put screw adjustments on their tools in such a way as to make it impossible to use self-hardening steel, making it necessary to machine grooves or peculiar sections on the metal to engage the screws. Then the tiny screws that are used, many only ⅛ inch in diameter, protruding nearly an inch from the holders, are invitations to disaster. Some tools are placed in holders parallel to each other and exactly the distance apart required to face opposite sides of a flange, say. How can an operator compensate for wear on the tools? Then we find tools piled over each other in such a way as to require the removal of several to get at a dull one. We have a set of tools (on the shelf) for making a certain brass piece in which the limits are small. No provision was made for a finishing cut on any surface. On inquiry we learned that the spring of the tool was to finish to size! Shades of our forefathers! cutting through hard scale and sand, and a sixteenth of an inch of metal and expecting the spring of the tools to finish within the .001 inch limit on the sizes.

How much does a builder add to his good name by sending out such bungling tools in the turrets that they cannot be rotated? We have two such cases. On one machine the tools struck the turret slide and in the other they were so long that the turret could not be run back far

enough to close the work, thus stalling the whole job. Were they ever tried before shipment? There was sent to us a special turret lathe equipped complete for a certain job of which we had sent the manufacturer some samples. When we set it up it was four inches too short to take in the work. Our samples, however, were returned finished. How were they done? If some tool designers could stand up long enough to try some of these wonderful creations their employers would profit immensely thereby.

ROGER HAINES.

Making a Valve Wheel Pattern.

Editor American Machinist:

Your readers may possibly be interested in this method of making valve wheel patterns in metal. Fig. 1 shows the casting required. This particular size is for 1-inch valves, and is used in considerable quantities. The castings were to be made on a molding machine. As the square hole tapered all one way the pattern could not be made with both halves alike.

The patternmaker being crowded with work, we had to use any castings we could find knocking about the place, the nearest we could find being as Fig. 2. These castings, twelve in all, were first drilled in the center, six of them to 5-16 inch and the others to ⅜ inch. The halves were then turned to fit one another, as shown by Fig. 3; the outsides and the plates also were turned as shown. The next operation was to notch the rim in six equidistant positions. This was done with a file, the positions being laid out with a pair of dividers, but would have been better of course if milled. However, we had to do with the tackle we had.

Next we made from a piece of scrap the chuck, Fig. 8, for boring the taper holes *d* and also cutting away the metal at *e*. These operations were done by the cutters, Figs. 6 and 7, which fitted the tailstock spindle. The halves being different at the center, two screws *c* and *c'* were required, and the chuck was bored to fit the boss of the top half, the shank of the large screw being turned to fit the hole in the pattern and also in the chuck, hence the same chuck came in for both halves. The portion marked *e* was first cut away by the cutter, Fig. 6, then the screw *c* was loosened just enough to allow the pattern to be turned to bring notch *h* into position of *g*. Thus in turning the inside was turned all around to the shape required. Afterwards by the cutter, Fig. 7, combined drill and reamer, the holes *d* were made. The tailstock spindle was in each case fed in to the same position by a micrometer screw and collar.

When these operations were completed the halves were bolted together and the outsides were filed to leave the rim an equal thickness around the holes. These were simply filed "to suit the eye." Then the square center hole was filed in to a templet.

All the patterns were mounted on one side of a planed cast-iron plate, with the necessary sprues, pins, etc., in the usual way. Before filling the flasks with sand and ramming up, dry sand cores were put in the central holes, with the largest end projecting about ½ inch from the pattern. Upon lifting the flask from the plate the cores were drawn from the pattern with the sand. Both halves of the mold were alike.

FRANCIS W. SHAW.

Hebden Bridge, England.

Press and Slip Fits.

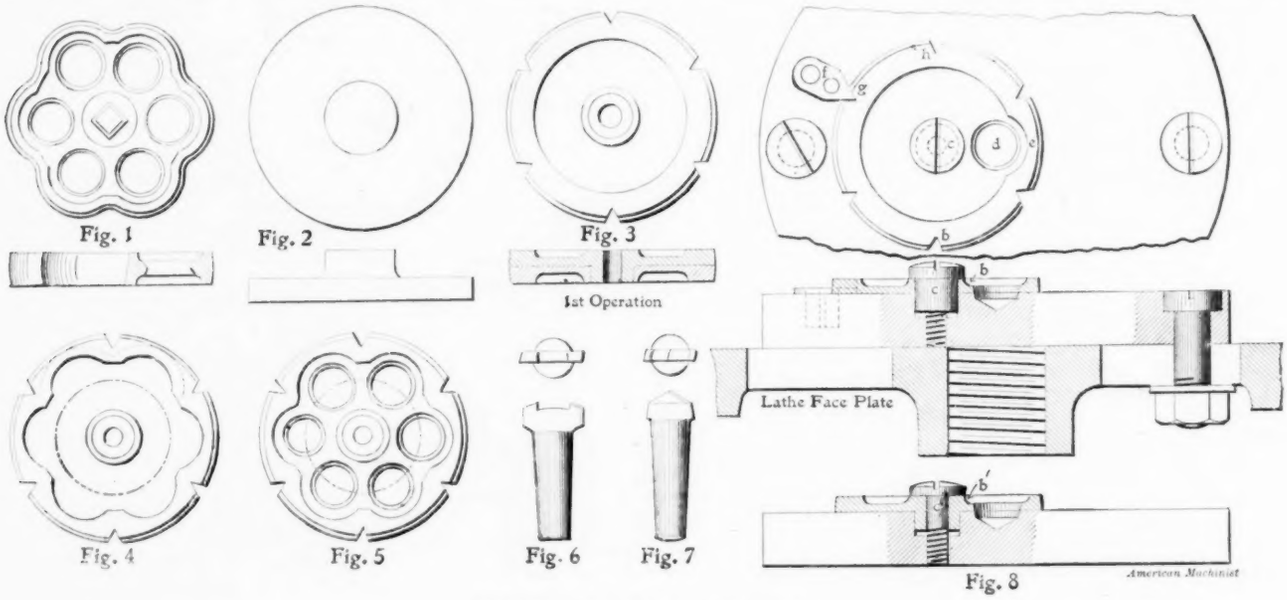
Editor American Machinist:

An article by "Job Lathe" appeared in the "American Machinist," at page 872, giving a rule for press fits, which reads: "Axially incline the calipers 1-16 inch per inch of diameter." To a previous article by Nick L. Steel, at page 631, the editor appends a table giving .0235 inch as the difference in diameters of rod and hole, when the rod is 12 inches and the inclination ¾ inch = 12-16, the correct inclination for a 12-inch hole, according to "Job Lathe." As the inclination is proportional to the diameter of the hole, the difference is also proportional. The figures in column 1 of the accompanying table were calculated on this basis.

Another article appeared at page 1241, by Mr. Geo. Jones, giving this rule: "Allow .001 inch for each inch diameter of hole + .003 inch." The differences for various diameters appear in column 2. "Machinery" of June, 1901, gives a third rule, which is ".0015 inch per inch diameter." The differences appear in column 3.

Now, what strikes me is that no two rules give the same difference for any diameter, and we are at sea as to which one to tie to. None of them take any account of the pressure required to force the shaft home, length of hub, roughness of the bore or shaft or the metals used, which I presume is steel into cast iron. These factors of course must be taken into consideration, and as they are all variable there is no hard and fast rule which is applicable to all press fits. As Mr. R. Safely says at page 145, "If the casting is of close-grained iron the elasticity of the hub is reduced, and the same allowance as for open-grained iron for a given pressure would send the pressure up 20 to 30 tons." He also cites a case where the allowance had to be reduced from .012 to .005 inch to get the right fit.

Each one of the aforementioned rules represents individual practice, probably under vastly different circumstances, circumstances which are met every once in a while. They cannot all represent usual practice. One may be just right for diameters from 3 to 12 inches, smooth bore and



MAKING A METAL WHEEL PATTERN.

shaft, with hubs two diameters long. Another may be right for diameters from 12 to 30 inches, smooth bore and rough shaft, with hub 1.25 diameters long. If one is correct for all diameters from 2 to 30 inches, which one is it? What feed shall be used to finish the shaft—20 or 50? How many tons will it take to send the shaft home in a hub 1, 1.5 or 2 diameters long? What is the ratio of the tons required for smooth bore and rough shaft, rough bore and smooth shaft, smooth bore

	Caliper Inclination .1" per 12" inch diam. Job Lathe.	.001" per inch diam. + 003. Geo. Jones.	.0015" per inch diam. Editor. Mchy.	Caliper Side Play Nick. L. Steel and Chas. Heena.	.0005" per inch diam. Geo. Jones
	Press Fits.			Slip Fits.	
Diam.	Allowances.				
3."	.00585"	.006"	.0045"	.0016"	.0015"
6."	.0117"	.009"	.009"	.0021"	.003"
9."	.01589"	.012"	.0135"	.00215"	.0045"
12."	.0231"	.015"	.018"	.00266"	.006"
18."	.0351"	.021"	.027"	.0043"	.009"
24."	.0468"	.027"	.036"	.0053"	.012"
30."	.0585"	.033"	.045"	.0066"	.015"

American Machinist

COMPARISON OF RESULTS OBTAINED FROM DIFFERENT RULES FOR PRESS AND SLIP FITS.

and shaft, the hubs of all to be of cast iron and the shaft of steel? What if both hub and shaft be of the same metal, cast steel or brass; what with cast-iron hub and heavy brass bushing, cast-iron bushing, steel bushing?

Information on these points is extraordinarily meager. The pocket books pay almost no attention to slip, force and shrink fits. Machinists who are skilled in this line of work seem to guess at the allowance; some use a thickness of paper, but paper varies in thickness, and so we find one man using one thickness and the next man a different thickness for the same identical job. These are all personal factors and cannot be incorporated into an engineering formula with the wall thickness, length and bursting stress of the hub, the modulus of elasticity of the hub and shaft metals, compressive stress of the shaft, coefficient of friction, tons required to assemble and separate, difference of shaft and bore diameters, etc.

All, or nearly all, of these factors can be expressed by known quantities. Unknown quantities like the coefficient of friction (which should not be expressed for metals in a dry state, 0.2, s these parts are always assembled with white lead or oil), tons per inch diameter and the correct allowances to make, could have their proper values assigned through laboratory research and engineers skilled in mathematics could derive empirical equations, give us rules easily remembered for shop use, calculate elaborate tables covering all points liable to arise in practice for the drafting room, and then blueprints can tell us the proper allowance to make.

Many of our technical schools have the required apparatus and skilled men to do this work, while the men who are badly in need of information on this subject, draftsmen and shopmen, are far too poor financially to attempt even the most crude experiments.

While on the subject of fits, attention to several articles on slip fits is found interesting. Mr. P. V. Vernon, of Coventry, England, at page 873, gives us rules for making slip fits on the principle of caliper side play. He also gives us the approximate and theoretical differences for varying side plays, and Mr. Chas. Heena, at page 378, gives the right play of the calipers for various diameters. By putting two and two together we get the results in column 4, showing the allowance for a few diameters. The article by Mr. Geo. Jones, at page 1241, allows .0005 inch per inch diameter. Allowances for different diameters by this rule can be found in column 5.

These two rules do not show up any better than those on press fits, even though there is nothing complicated in their theory, as there is in press fits; yet the parties looking for the right allowance to make are again at sea. Experience of course will tell, but the boss won't stand for any shake in that big gear that he wants "just right," and if that shaft sticks and binds in its boxes, Tom, Dick or Harry is in for a call-down. Though we can make the fits exactly right ourselves, how can we help out that ambitious young apprentice who wants to please everybody with his fits? Giving him the right allowance on two jobs will befuddle him on a third if he does not understand the basis upon which they are founded.

I would like to mention Mr. Wm. S. Rowell's article at page 1110, wherein he states the difficulties he experienced in selecting the right allowance and the difference in the result when calculated through the use of trigonometry, square root, proportion and Vernon's approximation.

The foregoing should not be considered a harsh criticism of the articles cited. On the contrary, the highest appreciation is entertained for the authors for their whole-hearted endeavors to assist those in need of help on these points, and I wish to extend my thanks for what I have learned from them. WM. A. BROOKS.

Chicago, Ill.

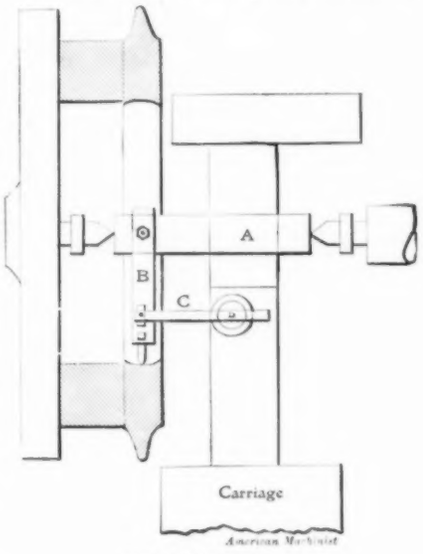
A Spherical Boring Rig.

Editor American Machinist:

I have been a reader of your paper for some time, and have got a great many useful pointers. I send you a sketch of a little tool which I made to bore out a spherical eccentric strap, 13½-inch bore and 2⅝ inches wide.

A is a bar, of any length, 1½ inches square, centered and held on the centers. *B* is 1 inch square, with a ½-inch hole drilled in the end to carry the tool. It also has a 5-16 inch slot in the under side to let a ¼-inch pin go in, which pin is in *C*, a tool held in the tool-post. *D* is a stud on which *B* works.

I noticed an article in the "American Machinist" about "Contagious Invention."



SPHERICAL BORING.

Almost the same thing happened with this tool. A friend of mine thought of the same thing, with the exception that he intended *A* to be carried in the tailstock instead of on the centers. However, he was off sick when I got up my tool, and I did not know he had thought of it, and when I got the "American Machinist" this week almost the same thing met my eyes in the spherical boring bar.

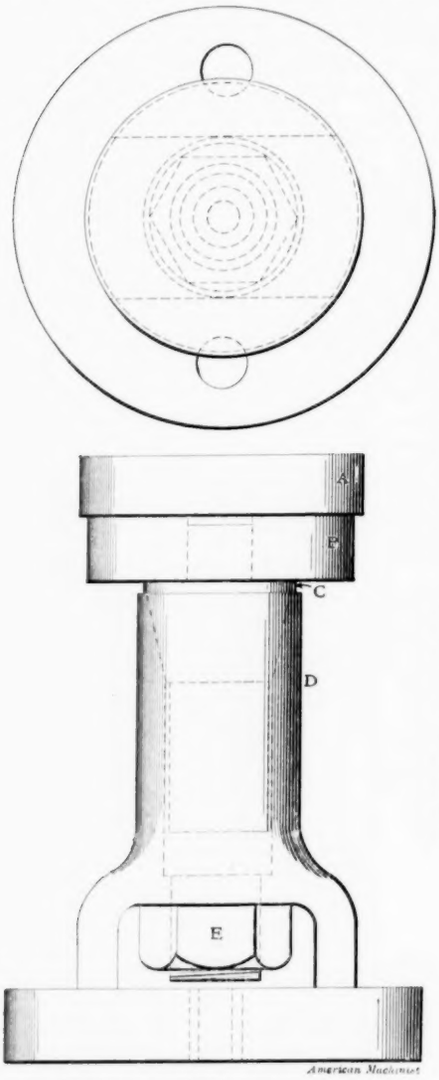
P. E. WOODWARD.

For Transferring Chucked Work to Different Machines.

Editor American Machinist:

It is often desirable in making sub-press dies to transfer the die to the milling machine, shaper or lathe to do some required work before removing it from the "solder"

chuck. This chuck is generally soldered to a piece of brass screwed on to the collet, either for the bench lathe or the engine lathe. The die is first turned into shape in the usual way, and when all is done that



CHUCK FOR TRANSFERRING WORK.

can be, the chuck is removed and put into the fixture *D*, which is used a great deal in watch factories but seldom elsewhere—at least, I have seen but one in all my experience.

The one here shown is made to receive a Pratt & Whitney collet for a 10-inch lathe; the other, if needed, is made to receive a chuck for the bench lathe, and will be some shorter than the one shown. They are made very nicely, being ground to receive the collet; the bottom also is ground and lapped. After the die is placed in the fixture it is just as true as when in the lathe, provided it has been made correctly, and is ready for the balance of the work. If it is to be milled, it is clamped to the platen of the machine or to a face-plate on the dividing head and worked out to the required shape. If to be drilled in different places for punches it can be clamped to the face-plate of the lathe and the holes indicated, or, if the holes come in a circle, it can be clamped to the face-plate of the dividing head.

It is a useful fixture and can be used to good advantage by die-makers and others. *D* represents the fixture and *C* the chuck or collet, which is drawn down and held in place by the nut *E*. *B* is a brass disk screwed on to the chuck *C* and to which the die *A* is soldered. There are, of course, several other ways of doing the work beside those which I here suggest. Every die-maker has his own way of doing his work.

M. W. LEECH.

A Combination Cone Pattern.

Editor American Machinist:

The accompanying sketches illustrate a cone pattern which has proven to be a success in the way of making one pattern answer a number of purposes.

Fig. 1 shows an ordinary machine or countershaft cone with four arms and a solid web, made with the idea of getting the greatest number of variations in the number of steps in various cones. The sizes are 12, 14, 16 and 18 inch diameters for a 3-inch belt.

Fig. 2 shows the construction of the pattern. The 14- and 16-inch steps were made solid together. The 12-inch step was taken care of by a loose ring which fitted into the recess of the 14-inch step, as shown. The hub and print were centered with a dowel pin which allowed the easy changing of hubs when desired. The 18-inch step fitted over the 16-inch, the depth of the recess being the same as the thickness of the metal connecting the 16- and 18-inch steps in the casting shown in Fig. 1. The reason for doing this will readily be seen by referring to the core box, Fig. 3, as the top of the 16-inch step corresponds to the top of the core of that portion, the loose step being centered by the recess and secured by wood screws. The print, shown with a dowel for centering, was also fastened by wood screws.

The core box, referring to Fig. 3, is made in such a way as to accommodate the changes in the pattern. The 12-inch step, being a ring, made its own core, the core for the 14- and 16-inch steps being made together, like the corresponding steps in the pattern, and the core for the 18-inch step is taken care of by a loose ring centered by a ledge and secured to the 16-inch step by wood screws. The core for the print is made in a loose ring which is centered by a ledge interchangeable with the ledge which centers the core ring for the 18-inch step and secured by wood screws.

The pattern was made with comparatively no extra cost, and allowed the following combinations to be made with but a few minutes' work in changing the pattern:

1. The complete pattern, as shown in Fig. 2, with four steps—12, 14, 16 and 18 inch. 2. A 14-, 16- and 18-inch cone is made by leaving off the loose ring for the 12-inch step. 3. A two-step 14- and 16-inch cone is made by removing the 18-inch step and also the print and securing the latter to the 16-inch step, a dowel hole being made for this purpose, the change of the core being made by removing the loose

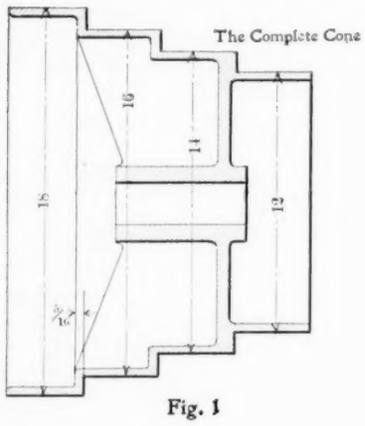


Fig. 1

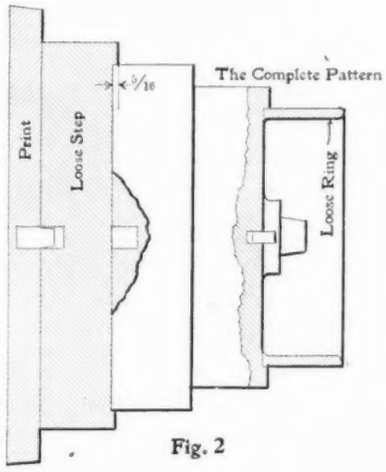


Fig. 2

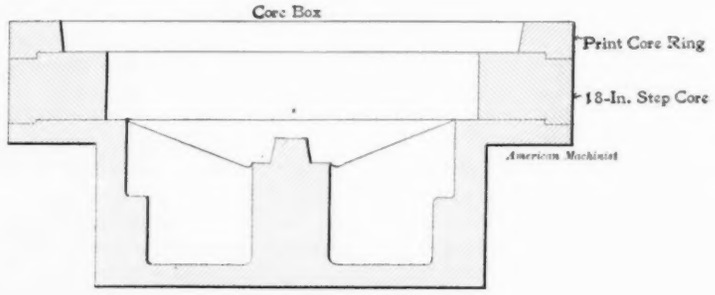


Fig. 3

A COMBINATION CONE PATTERN.

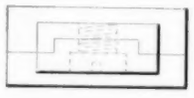
ring for the 18-inch step and securing the ring for the print core in its place, the ledge or groove having been made interchangeable. 4. A 12-, 14- and 16-inch combination by simply adding the loose ring for the 12-inch step to combination No. 3, no change in the corebox being necessary.

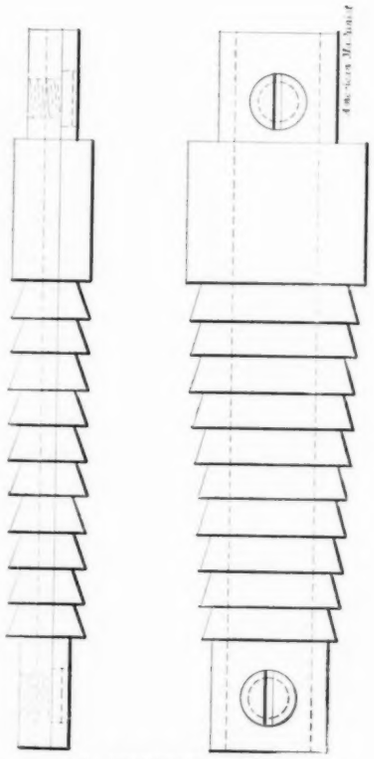
The overhanging core print shown in Fig. 2 has given more satisfaction than the cope print, which is frequently made and which necessitates the core being hung in the cope, and unless the cope and the drag flasks fit perfectly there will be a difference in the thickness of the metal on the sides of the castings. With the overhanging print the whole mold is self-contained and the thickness of the metal is more certain to be uniform. J. B. G.

An Adjustable Broach.

Editor American Machinist:

I send you a sketch of a broach that had a hard time coming into existence but that did a lot of work after it came. We had several thousand castings to broach out, and as there was only 1-1000 limit above or below the size wanted, it kept the toolmaker all the time setting out the broaches and stoning them down. Finally I made a broach in two parts, locked together like the sketch, and held with two countersunk screws, so that it could be packed out with paper and kept to the desired size. It was finished and sent to the smith's to be hardened, and that was where the fun came in. It should have been sent in separate pieces, and he should have taken it apart even if not so sent; but he put it in and hardened it as it was, and when it came back to me it looked like thirty cents. It was warped all out of shape and was sprung 1-16 at each end. I took it apart, straightened it, hardened each piece separately, ground them and put them together, then packed it out to the size wanted and put it to work.





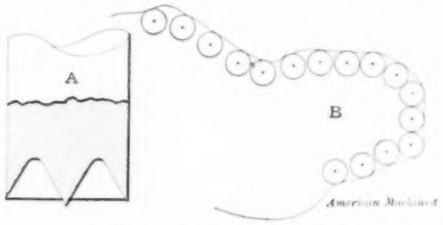
AN ADJUSTABLE BROACH.

We roughed out the holes with an ordinary broach and just used this one as a finisher. It was used for the whole lot of castings, and we had no trouble in keeping it to size. A. P. PRESS.

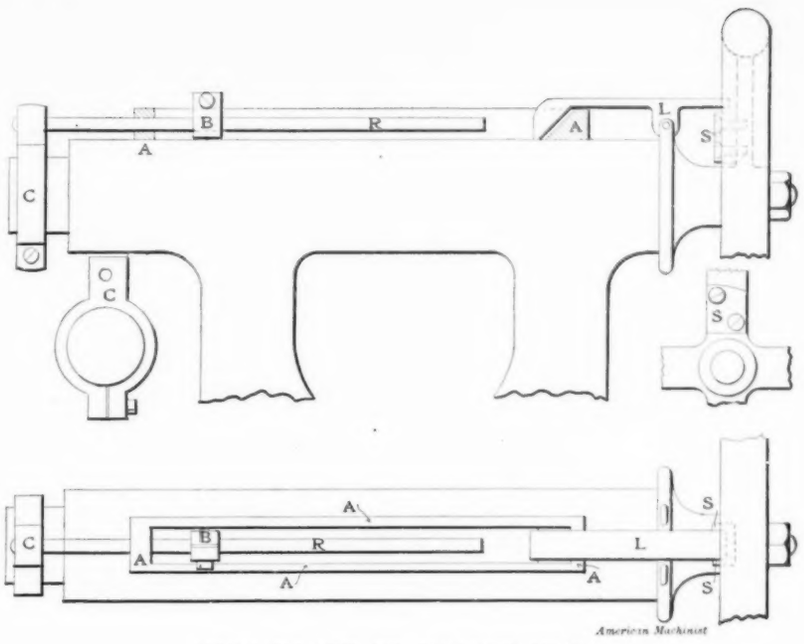
A Spacing Center Punch.

Editor American Machinist:

Mr. Putnam's suggestion on page 1360 reminds me of a punch I have used for some time in making dies, and which I have found invaluable when removing stock by drilling. If, say, a No. 10 drill is used, procure a piece of drill rod of the same diameter, about 2 inches long, and after filing off one end place the other in the lathe, square it and cup it out as shown enlarged in the sketch at *A*. It should be hardened and is then ready for use. When located upon a piece of metal and struck with a suitable hammer it will produce a circle with a center. Strike these circles around the outline as at *B*, and drill. There will be no trouble about having the holes run into each other, nor of going outside the line. A. R. BAILEY.



A SPACING CENTER PUNCH.



ADJUSTABLE STOP FOR TAILSTOCK SPINDLE.

Adjustable Stop for Tailstock Spindle.

Editor American Machinist:

The sketch shows an idea picked up in a small shop where there was no drilling machine to speak of. It is a stop for the tailstock spindle of a lathe, handy as a gage in drilling. *C* is a clip on the spindle with a rod *R* in it running back over the body of the tailstock with an adjustable block *B* on it. *A* is a slotted bar kept in place by the rod *R* at one end and by the lever *L* at the other end. When the spindle is fed out the block *B* strikes the forward closed end of *A*, carrying it forward until the oblique face at the rear end strikes the overhanging end of lever *L*, throwing that end up and the other end down until the latter strikes the pieces fastened to an arm of the hand wheel and stops it. *B* being adjusted according to the depth of the hole to be drilled, succeeding holes will be stopped at the same point.

ROBT. H. LAGHLIN.

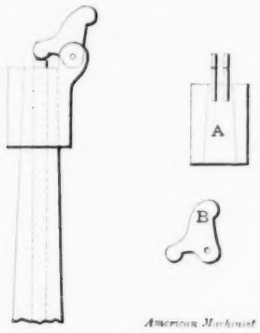
Liverpool, England.

Attachment for the Test Indicator.

Editor American Machinist:

On page 1011 Mr. M. H. Westbrook shows a test indicator which I must say, after trying it, is a very good tool. I send a sketch of an improvement which doubles the usefulness of the indicator. It is an attachment for truing holes, also buttons or other projections on jigs or fixtures on the face-plate when bolts or clamps are in the way. The sleeve *A* is reamed with a taper reamer and the barrel end of the indicator is fitted to it so that it can be taken off when not wanted. It is

not necessary for it to be tight. The finger *B* is rounded at both contact points and hardened. I find also that the index plate



ATTACHMENT FOR TEST INDICATOR.

can be dispensed with. I graduated the body of the tool, which is all that is necessary. J. F. B.

Cleveland.

Die Sinking for Drop Forging.

Editor American Machinist:

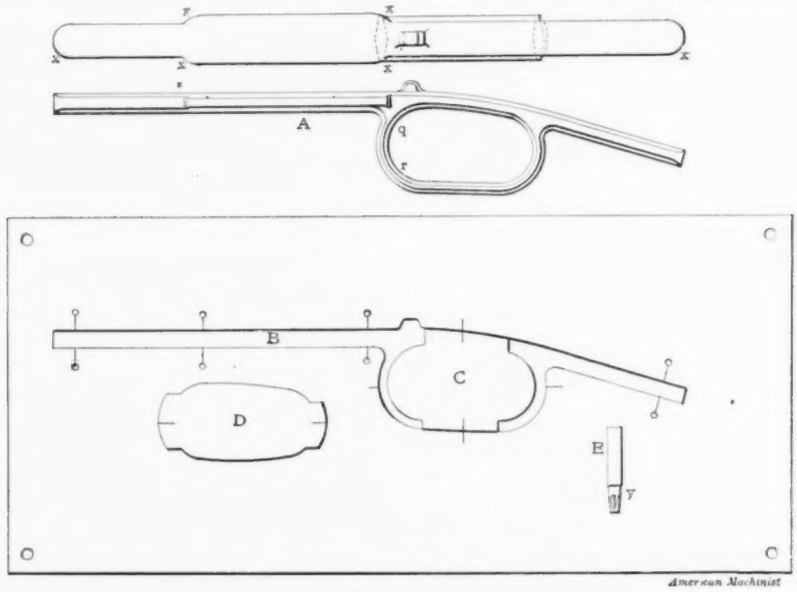
I had at one time a number of duplicate sets of drop-forging dies to sink by the piece, and when the men on the job learned the price I took them for they smiled and said I would not make day pay. There was not only day pay, but the limit of piece-work pay was reached and some time to loaf to make things balance, so that there would not be an inquiry from the office. As the scheme may interest some of those who are sinking dies, I will give it for the benefit of the craft:

The piece to be forged was a part of a rifle which figured very extensively in our recent settlement with Spain. It consisted of magazine plate, trigger strap and lower tang combined in one piece, and was like Fig. *A* as near as I can remember it. The first operation was to make the usual zinc templet, first drawing the finish lines and then adding finish and draft, as will be understood by all die sinkers. Next a piece of tool steel was got out ⅛ inch thick, and the size of the face of the finishing dies, which I believe was about 8x12. The blocking dies, which in this case were steel also, were about 12x12, but by working from one side and end the difference in size did not matter. After squaring the plate nicely, four holes were drilled in the corners, as shown, care being taken to see that they went through square, so that the plate would reverse without being out of square on the die.

The zinc templet was then clamped on the plate in the required position and marked around, and the plate was drilled and filed out to the form of the templet, as shown in *B*. Two small templets, *C* and *D*, were then made the shape of the inside of the trigger strap, with projections, as shown, to fit in the large templet, and with the locating marks put on. These pieces were held in position with solder and were taken out or changed as desired. The templets were then heated, the edges were rubbed with cyanide and dipped in oil, giving them temper enough to resist the stem of the cutter, whatever pressure might be put on it.

I now had a nice profiling former, and after making some cutters like *E* of ¼-inch drilled rod I was ready for business. The templet finished, it was carefully set to one side and end of a die and clamped, and the four corner holes were drilled to a depth sufficient to hold a pin securely and reamed, and then reversed on the mate die and the holes drilled and reamed, always working from edges which would coincide when the dies were face to face, and always reversing the templet. Pins were next fitted to the holes, the outline was scratched on the dies through the templet and traced with tracing chisels, and the impression was roughed out with the usual two-lipped cutter. The templet was then put on and the cutter *E* was put in and the last trip around was made with the hole full of oil and the fastest speed of the machine. The lines *o* were put on for stop marks and the shank *y* of the cutter served as a former pin on the templet. As the impression was of different depths, cutters had to be made with a length of taper corresponding to each depth. The only chipping was at the circles *x* and from *q* to *R*, the trigger strap being wider than the tang. The cutter worked so nicely that it was only necessary to file where there was chipping. After cutting out for stock clearance and putting in the sprue cut, the dies were "flashed" and a cast was taken to prove the chipping only, the match being perfect every time.

I will say here that there were six pairs of finishing dies and six blocking dies, making twenty-four impressions, and the balance the first of the month was very satisfactory. THEODORE.

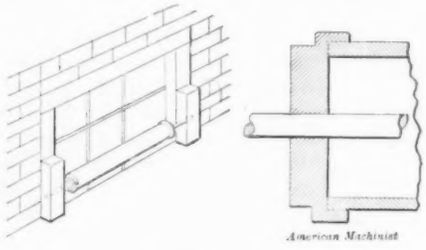


MAKING A DROP FORGING DIE FOR GUN WORK.

A Pipe Roller.

Editor American Machinist:

Here is a sketch of a roll in the basement window of a wholesale pipe house here. The basement is used for storing pipe which is passed in and out of the window. Some ingenious plumber, to make the roll, took two 3-inch pipe caps, drilled a 1-inch hole in the center of each and screwed them on to the ends of a piece of 3-inch pipe. A block was spiked to each side of the window with a 1-inch hole in each and a 1-inch rod was shoved through, which carried the roll. The rod was held by a couple of nails.



A PIPE ROLLER.

F. W. HARRIS.

Pittsburgh, Pa.

Holding Straight Shank Cutters in a Collet.

Editor American Machinist:

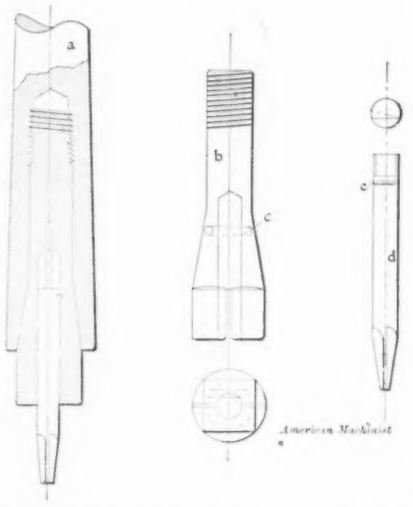
To hold a plain straight shank cutter in a collet is a difficult job, which more than one die-sinker has learned to his sorrow, and many die faces have been planed off because an inconsiderate cutter failed to stay in place while working at the bottom of the impresison.

Having at one time a quantity of dies to sink with very narrow impressions which required delicate cutters, I devised the scheme shown in the accompanying sketch which worked very satisfactorily. I started with the very old scheme of a set-screw through the side of the collet and a hole spotted in the shank of the cutter; but as this threw the cutter out of true, making a one-tooth cutter, as it were, and

as the screw persisted in working loose every few minutes, necessitating a stoppage of the machine to tighten up, it was not just the thing for piece work, and something better had to be devised.

a is a taper shell to fit the spindle of the machine and is stiff enough to stand pushing in to place to stay. It is bored taper at the mouth and tapped, as shown, to receive the screw in collet *b*, which has a hole the size of the cutter shank and the pin *c* crossing it at right angles, and about one-third the diameter of the hole. The end of the collet is squared to fit the vise wrench used on the machine; *d* is the cutter which is filed down on the end to pass the pin *e* when inserted in the collet. A slight turn causes the nick *e* to hook over the pin, making it impossible to remove the cutter without turning it back, and as the nick is put in the left-hand side, the pressure of the cut tends to keep it in place.

A shell was also made to fit a lathe spindle and receive the collet *b*, so that in making the cutters they could be held as in the die-sinking machine. This insures the cutters running true even if the collet is



HOLDING STRAIGHT SHANK CUTTERS IN A COLLET.

out some. I think an outfit like this, with collets for ¼, 5-16 and ⅜ inch drill rod, will bring joy to the heart of any die-sinker who is not already fortunate enough to possess one. THEODORE.

Making Pawls.

Editor American Machinist:

Fig. 1 shows a pawl to be made in considerable numbers, and this is to tell of their making. I suppose the sketches are nearly self-explanatory. The stock is first planed in strips to the right thickness and to the width *a*, and is then sawed to the length *b* with a gang of saws, using the vise jaws, Fig. 2, pushing the stock endwise against the gage pin *a* before tightening. By care in squaring the collars between the saws to the required length, using saws as small in diameter as the work will permit and thick enough to stand the work, the pieces can be sawed so accurately as to require no other machining on the ends. I personally think that the quickest and best way to make gang saws cut to length is to have the collars between the saws rather shorter than required and to adjust with paper washers.

The next operation on the pawls is drilling, using the jig, Fig. 3, in which a piece is shown clamped in position. On throwing up the cam lever and drawing the binder *B* to the right the piece can be lifted out after it is drilled. The pin *b* is not intended to touch the work, but prevents its being put in wrong, as it is longer the other way. A spring is provided at the corner *a* to press the work against the guide pins. The jig is of course turned over for the drilling, standing on the four corner studs.

After the drilling the vise jaws, Figs. 4 and 5, are used to hold the pieces for milling to shape. At *a*, Fig. 4, the heaviest cut is taken, and for this perhaps two cuts will be required. The end screw helps to hold the work against the gage pin for this cut. At *b*, *c*, *d*, *f* and *g* one cut is sufficient, but at *e* two cuts. With three special formed cutters one cut at *a* and *b*, one at *e* and one at *f* and *g* could be saved, but formed cutters are expensive, and it would not pay unless large quantities of the pawls were to be made.

For the last operation, drilling the pin hole, the jig, Fig. 6, is used. No means are provided for holding the work on this jig; the hole is so small it was thought not necessary. MAC.

Making Worm or Screw Patterns.

Editor American Machinist:

S. H. Ortway's letter, on page 1340, about "Cutting Worms or Screws on the Circular Saw," is interesting and instructive, and for producing this class of work in this particular way it may be all right, but to my way of thinking there happens to be a better method.

Let us assume that an order has been received at noon for a worm pattern, 7 inches outside diameter, 2-inch pitch, with a depth of tooth of 1 inch, and an over-all length of 11 inches, the hole to bore for a 2½-inch shaft, with the seemingly unreasonable request that it be ready to cast the next day. Just to show off a little, we decide to get it cast the same day, and this is how it can be done.

A block is turned in halves to form the body, as shown in the sketch, to the diameter at the bottom of the teeth, 5 inches, and long enough to provide for core prints. Then two half rings are band-sawed to the inner and outer diameters of the teeth, 5 and 7 inches respectively, care being taken to use stock of sufficient thickness and width to make a sawing jig out of the remainder of one of them. Next we make a triangular templet of flexible cardboard, to scribe the pitch lines of the base on the inside of the tooth stock, and to lay out the same we take the pitch, 2 inches, as our perpendicular, the inside circumference, 15.708 inches, as the base, and draw the hypothenuse to connect them. We set off as many tooth sections as we need by simply bending the cardboard to conform to the semi-circular shape of the tooth stock, the hypothenuse giving us the desired pitch line. Now with the surplus stock allowed on the back and sides of the tooth stock, we make the sawing jig and as this worm calls for a tooth with a 15-degree angle at the sides, we tilt the band-saw table to that angle and fasten the sawing

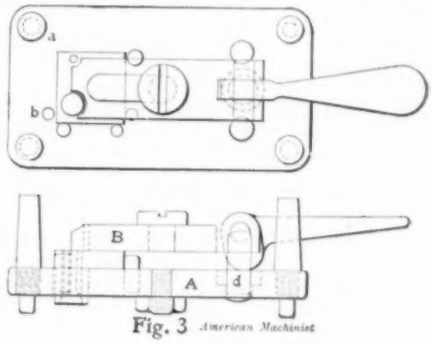


Fig. 3

DRILLING JIG FOR PAWLS.

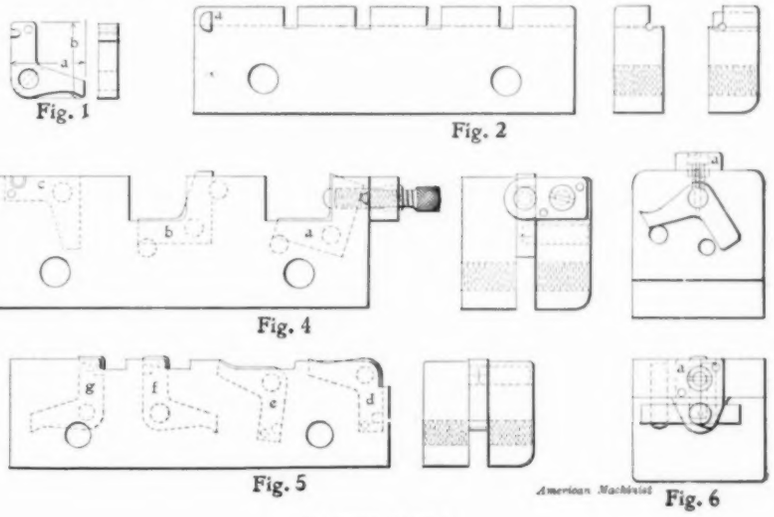


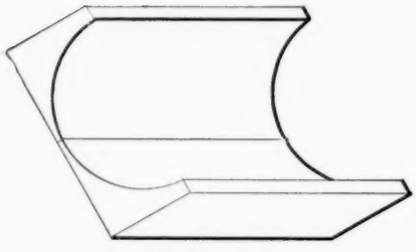
Fig. 1 Fig. 2 Fig. 4 Fig. 5 Fig. 6

MAKING PAWLS.

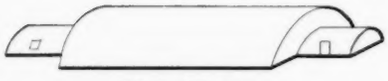
jig to it with a single wood screw through the saw slot. The angle at which the sawing jig is fastened in its proper relation to the saw blade is found by using the pitch, 2 inches, as the base and the outside circumference of the worm, 21.99 inches, as the perpendicular. Now having our jig in position, with the saw points coming exactly in the center of the circle,

Half Pattern.

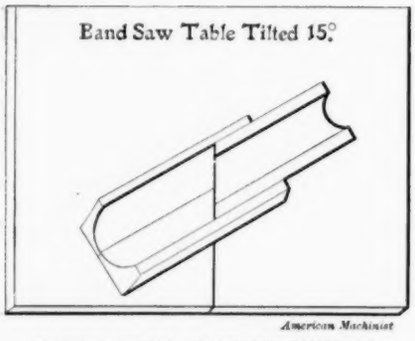
Tooth Stock.



Sawing Jig.



Half of Body.



MAKING WORM OR SCREW PATTERNS.

we are ready for business, and after sawing as many tooth sections as we need, sawing one side guided by one end of the jig and the other side of the tooth guided by the opposite end, the tooth stock having made a half rotation each time, and producing a perfect job, we just glue and nail them in their proper positions on both halves of the body. Finishing the ends to the usual shape, with a little sandpaper here and there, and *sans* varnish, we are ready for the molder about 4 o'clock the same day. When the party comes for the pattern the next day he gets it and the casting, too, at which he expresses surprise. He also expresses surprise at the size of the bill; but when we explain that we not only charge for doing the job but for knowing how, he pays, not without a few remarks "touchin' on and appertainin' to" highway robbery, etc., etc.

If the worm tooth is to be shaped as gear teeth usually are, saw the same to the base line with sufficient angle on the sides, so that there will be as little as possible for the turning tools to take off, which obviously should only be attempted with the lathe running at a very slow speed.

We recently made a house mover's jack screw and base by this method, and the thread sections for both the screw and the corebox for the base were sawed from the same stock, and gave perfect satisfaction.

OLD BOB.

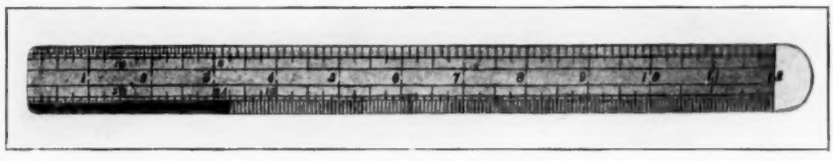
Another Spacing Center Punch.

Editor American Machinist:

I have paid scanty attention to the discussion that has been going on over spacing center punches, never having had use for such a tool in my own shop experience, and so I may be sending you something already published, for I cannot believe I am the first to see so obvious an improvement as the one I herewith submit. In the punch shown on page 1357 the spacing wire is brought up nearly parallel to the punch, giving little chance for spring and that little at the worst possible angle for accuracy. At the risk of bringing down on my head the wrath that has fallen on Mr. Fulton's, I suggest that by making the wire as shown in the accompanying sketch the tool can be used for the final heavy blow as well as for the first light one that merely pricks the surface. In my sketch the springing should be mostly at *a*, thus not affecting the spacing.

One of the first thoughts a fellow has when he alights on something of this sort is: "This is so simple it cannot be new. Someone must have thought of it long ago."

E. R. PLAISTED.

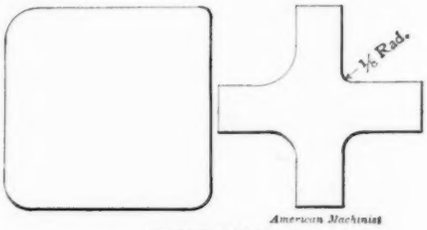


SCALE OR FILLET GAGE?

Fillet Gages.

Editor American Machinsit:

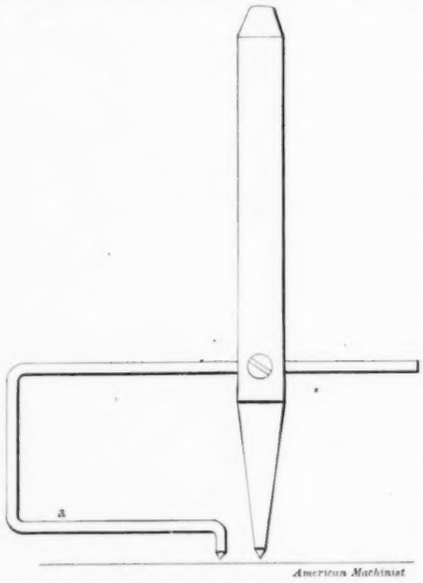
I quite agree with the remarks of M. F. Wertheim on page 878 about fillet gages and have often wished I could buy a few made, say, in the style that Starretts make their tools. I enclose a sketch of a pair I made for my own use, which are as often loaned as used by myself. Made from steel 1-16 inch thick, I find them very handy.



FILLET GAGES.

While on the subject I might add that, wishing to use one of a different radius from any I had, I asked a fellow-turner "just out" from England, who says there are no good mechanics in this "kentry," if he had any in his possesion that he could lend me. He said he'd never seen any; when he wanted one he filed it out of a piece of tin. While saying this I noticed him taking a size (?) with the original of the enclosed photograph. I got the drafting-room boy to take a snap of it without the knowledge of the owner. I fancy it's a better fillet gage than scale. What do some of the other readers say?

CYNIC.



ANOTHER SPACING CENTER PUNCH.

Competence and Ease—Incompetence and Discomfort.

Editor American Machinist:

Looking over the columns of the "American Machinist" of any date, one sees the finger marks of competent mechanics.

mostly journeymen, a few employers and many executives. Looking over the employees of any shop, one sees the competent men leading a comparatively easy life, taking hold of any job on a moment's notice, going at it in a methodical, systematic manner, with a familiar touch and an easy swing and achieving results beyond the pale of unfavorable criticism. There is no haste and no waste with their accompanying disturbances, no need of the foreman standing over them, correcting their fits, setting the tools and doing the job himself after all, while the incompetent man with the same conditions perspires, curses, asks fool questions, takes twice the time to do the same job and makes a botch of it after monkeying around in a half-hearted, indifferent and disgusting way.

Employers as a rule are competent mechanics, and generally have served their time from tool-monkey up, climbing from one place to another by strict attention to the job in hand and a diligent application of brains and common sense to all things appertaining to the business, both inside the shop and the office. Occasionally, however, one finds an exception, which proves the rule (?). A most remarkable case of this nature came to my notice a short time ago, while working in a small shop, on punch and die work. My employer had been engaged for the preceding twenty years in the manufacture of an electrical appliance, made up mostly of stamped sheet metal. He had used power for many years, often took up a small odd job, made many of his dies, and Bradstreet rated him at five integral places.

A job came along involving the installation of sixty incandescent lamps, necessary wires, switches, switch-board, dynamo, etc., the belts, countershaft, dynamo and pulleys to be supplied by the owner, the contractor to decide the sizes of each. A wireman was detailed on the job, but he knew nothing about the mechanical end of it, so the boss said he would be there to see him through. The boss asked me how to figure the speeds of the pulleys, then he said he would run the counter at 600 revolutions per minute. I succeeded in cutting this down to 450. He considered it necessary to cross a 4-inch double belt, running at 2,000 feet per minute from counter to dynamo, to carry 7 horse-power, while a 3-inch single open belt, running at 900 feet from line shaft to countershaft, was also expected to carry 7 horse-power. It was put up this way under my protest, and a brilliant (?) failure was the result. It was then necessary to show Mr. Kent's figures to get belts of the right size. It was decided to put two small flywheels on the countershaft, a gas engine being the prime mover, and giving a varying light. These were taken from a small gas engine and weighed about 250 pounds each, counterweighted of course, but no attention was paid to that. The result can be imagined. No one was hurt in the discovery of the action of centrifugal force. A foundation 15x4x5 feet deep was put in for a machine weighing 500 pounds and a countershaft weighing 600 pounds. When the hangers were taken down the strips were taken out of the boxes and thrown away, leaving the boxes loose on the shaft and in the hanger. The wheels had not yet been balanced and were again put up, as at first. Of course the shaft ran the same as before.

The cause of all the trouble was then found; the wheels were balanced, the boxes fitted and shimmed, the shafts lined up and leveled, the machines were properly fastened, and now they run all right. But what a botched job! Had a competent mechanic taken hold of it at first it would have been done right once for all in less than half the time, with no belts and pulleys to put on the shelf, no shame-faced excuses to offer and no contempt from employees.

"A little knowledge is a dangerous thing" should be changed to "too little knowledge is a dangerous thing," and too little technical knowledge certainly is a serious handicap when you attempt a job a little out of the ordinary routine of your business. A man who knows why he does a certain job a certain way will know why it cannot be done a certain different way, and also how it can be done another different way, and the feed of his think trap need never be out of gear (as Philosopher Osborne says), devising new ways of doing a job quicker and better or a way to do a new job and do it right to begin with. "Every man is the son of his own works" and "if the young man knew and the old man could, there's nothing but would be done," are two axioms worth remembering, and their scope is universal.

WM. H. BROOKS.

Chicago, Ill.

Some Questions About a Die.

Editor American Machinist:

On page 1231 Mr. Joseph V. Woodworth contributes an article on blanking and stamping a fancy shell. Will Mr. Woodworth kindly answer a few questions in regard to it?

First: Was it impossible to make the stamping punch he illustrated solid—that is, without a hole bored in the center and inserting a stud? I have made quite a number of similar pieces and have never found any projection that would interfere with the finishing of a surface.

Second: Why did he carefully "anneal the die in an *air-tight box* in powdered charcoal until it was as soft as possible," and then heat it to a bright red and strike it in the drop with the punch fastened in the head of the hammer? When the die would be taken from the drop after being struck two blows it would be nearly cold, or black hot, and cooled off this way it would not be very soft, especially where it was struck. This would necessitate annealing over again, and as it had to be put in the drop four or five times there would be considerable waiting before it cooled off each time.

Third: Why was it planed, dovetailed and finished on two sides before it was submitted to this method of being heated red hot four times and the punch stamped into it? Would it come out of the drop in as good shape as it went into it after being heated red hot four times and the punch stamped into it? Would it come out of the drop in as good shape as it went into it after being pounded like this? I think not. It would have to be planed and finished all over again.

Fourth: Could it not have been hobbed in cold by using a press? A shallow depression had been turned in the die. If this depression had been turned to a templet made to fit over the punch at the deepest part of the corrugations and the hole in the center made exactly to the size of the tit in the center of the punch, this would be a comparatively easy job, because there would be only just the depth of the corrugations to cut away. By the use of a few nice chisels, some scrapers and graving tools to smooth up with, then putting the punch and die in a press, turning the wheel by hand and giving a good hard blow to show the bearing, taking it to the bench again and relieving the hard spots, returning to the press, another hard blow, and so on, alternately relieving and striking again, a much nicer and quicker job can be done. I know lots of men who would rather sink a die this way than take a day off fishing.

Fifth: Why was the edge of the blank scolloped when a plain round blank only was required? This is astonishing, but it is true. This punch and die would form a plain circular blank, if of the correct diameter, into the shell shown in the half-tone. Naturally it must be so. The corrugations are on the die and the metal is forced into them, giving the scolloped effect. If the edges of the blank were scolloped the shell produced would be very pointed at the end of each corrugation, instead of being as the photograph shows it to be. It is "up to" Mr. Woodworth to explain this.

Sixth: Why did he use a blank-holder on this stamping die? Blank-holders are used to keep the metal from wrinkling, but we need not to keep the metal from wrinkling in this instance, because the corrugations absorb the wrinkles and a deeper corrugation can be made without bursting the metal than if a blank-holder were used. A blank-holder is a detriment here. This is not a drawing die. Some stamping dies require them, but not this one.

Now, as to the blanking die, why did he put a spring stripper on a simple blanking die? Was it any cheaper than an ordinary one? I think not. It is a recognized fact that spring strippers are always a necessary evil and only to be used as a last resort when, owing to some peculiarity of shape, no other kind can be used.

Seventh: Why was the shear put on the die instead of the punch, which is much easier done? Was it to keep the blank straight? He says the metal was very thin. Now, when this is the case it is not necessary to shear the die, because the metal will not take the shape of the punch, owing to its lightness; it will spring back straight. If it were heavy metal I could understand it.

Eighth: Why did he give the cutting or blanking die so little clearance as less than ½ degree? Is he not aware of the fact that when he hardened this die it would have no clearance whatever? All straight surfaces become more or less rounding in the process of hardening, and as the walls of this cutting die are straight through and through the same effect takes place there, and if they come out with any clearance in a case like this it is a piece of good luck only. In all light metal for blanking dies the rule is to give 2½ degrees clearance right up to the cutting edge, because a perfectly clear cut free from burr can only be obtained this way. No matter how sharp the edge is, if the walls are straight, there will be a slight burr caused by rubbing on the sides of the die. Keeping the blanks to size "cuts no ice" on thin metals such as light brass or tin, because there is very little wear on the dies and they do not have to be ground often. Millions upon millions can be cut without any appreciable difference; so giving "little or no clearance" is providing for the day that will never come. Mr. Woodworth is not the only one of your contributors who errs in this respect. For heavy metal it is quite different, as the dies must be ground frequently, and it is always more necessary to keep them to size.

B. J. DOUGHERTY.

A Keyseat Rule.

Editor American Machinist:

Here is a new idea on a "large and small scale": If one has to lay out a keyway on a shaft and is without a keyseat rule he may be able to find in his tool box a rule such as we use in a combination square, with a groove in the face of it, and, if he is fortunate enough, he may find also a scale of any length that may set into the slot, as shown. If so, put them together and you have as cheap a keyseat rule as ever was used.

C. W. PUTNAM.

A Permanent Snap Gage—Limit Gages.

Editor American Machinist:

In commenting on Mr. Putnam's snap gage shown at page 1337, you say that it is "obviously impracticable to make these of different dimensions to act as limit gages." Accompanying sketches show three practicable ways of accomplishing this, and I believe they have been used before. Fig. 1 shows one method, part *A* having been lapped or ground away .001 or .002, according to the limit desired. In Fig. 2 one side is made in two parts and center piece C is reduced on one end the desired amount. Fig. 3 shows center piece parallel and part *A* held away the desired amount by paper. In making a limit gage, I suggest that the ends be made different, as shown in the sketch. This enables the user to tell at a glance which is the large or small end and facilitates the measuring of the piece when lapping or grinding piece *A* to allow for desired limit of variation in piece to be gaged. W. R. G.

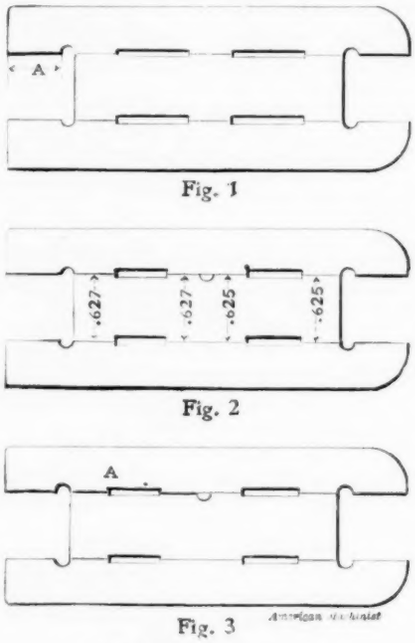


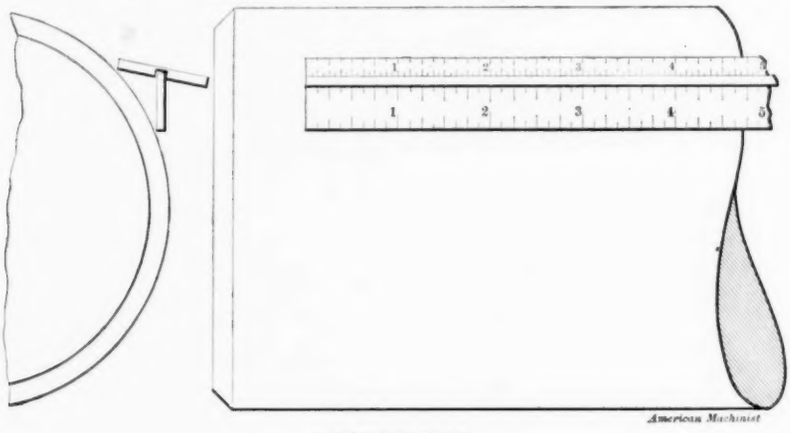
Fig. 1

Fig. 2

Fig. 3

PERMANENT SNAP GAGES.

[The great merit of this form of gage, as we stated in the comments on Mr. Putnam's article, is that the more expensive center piece which determines the size is not subject to wear, in consequence of which the correction of the gage, when worn, becomes simply a matter of resurfacing the jaws. The construction of Fig. 1 throws part of this advantage away, as the desired difference between the limits is in the jaws, and this difference must be made afresh whenever the jaws are ground. There are no objections to Fig. 2 after it is once made, but the original lapping of the center piece is much more difficult. The gage is really two complete gages in one structure. Of course many shop gages are made without lapping, and in the present case, if the work of a surface grinding machine was considered good enough for the purpose, the construction of the center piece of Fig. 2 would not be materially more expensive than that shown by Mr. Putnam. Regarding Fig. 3, nice adjustment can of course be had through the use of paper as described. It seems to us, however, that this form of gage makes it feasible to dispense with reference gages. The center piece becomes a permanent record of the size, and for such a purpose it does not seem to us that the use of paper is desirable, though good working results can, no doubt, be obtained in that way. The construction shown in Fig. 1 is the one we had in mind when writing the footnote to Mr. Putnam's contribution.—Ed.]



A KEYSEAT RULE.

Private Stocks of Tools.

Editor American Machinist:

I was much interested in that part of W.'s article on page 1343, which referred to the private hoarding of tools, and I think it will touch a responsive chord among machinists generally. I would like to give a few reasons why these practices have a place in our shop, without defending or condemning them more than I can help.

If a careful examination was made, it would be found, I think, that the men who have the very best little private tool departments are the very best men in the shop and the ones most valuable to their employers. Now, the best men help to make the reputation of a shop, and all of them are not efficient exactly because they were born that way and could not help it. Some of them have accomplished something in the way of efficiency by thinking and trying, backed by a definite purpose to make something of themselves, and what these men do there must be some good reasons for. About half the men in a shop will never make a makeshift tool to facilitate any shop operation. They would rather hunt about the shop long enough to make

one, and then, not finding it, resort to any old way to do the job.

There are nearly always two or more ways to do a piece of work, and the man who will hurry to make some little contrivance to help himself out of a hard place might frequently feel inclined to proceed with some less expeditious way if he knew that some tool which he might make would have to be turned into the toolroom.

The tools a man will accumulate in this way are worth more to him than to anyone else. He will find uses for them that others would not, and they will save him many a trip to the toolroom. There are some things that a man will do and others that he habitually will not do. He may be stopped now and occasionally by a club or a reprimand, but if he has what to him are good reasons for his course of action, he will be apt to follow out his plan when he can.

Suppose a workman has occasion to make a small boring tool, either for a lathe or in the form of a boring bar to be used in a chuck in the milling machine, for some special job, and that he can see where this same tool would have been handy on other jobs that he has done and will be useful also in the future. Now, he knows that most of the men are looking for just such things as these and yet would resort to almost any makeshift rather than make one, and that if he turns it into the toolroom the chances are very much against his finding it again. He is ambitious and wants to see his work go along; he knows the boring tool is a good thing and does not want to stop to make others, so he simply takes care of the one he already has.

Then there is the question of laps. After a man has been to the toolroom a few times to find one to lap out a bushing, and finds none really suitable, and finally has to make one, for a hole that is a different size from the rest, and gets a really fine article in the way of a lap, it seems like parting with a good friend to deliver it up. Didn't he lap that last hole, including the time spent in making the lap, which was hurried, quicker than either of the other holes? The other laps were small and he had to keep hammering them up, and even then he couldn't keep them charged with emery properly to fill the hole. If he wanted that good lap the next day, if it was turned into the toolroom, it would be in as bad a condition as the ones he had so much trouble with.

We will consider the case of the shop where there is not a reamer under ¼ inch, except perhaps one 3-16 inch and one ⅛ inch, that are .002 or .003 inch under size, and yet holes have to be put in right along between a very small one and ¼ inch that there is as much need of reaming as there is of the larger holes. The ideal way would certainly be for the shop to keep a supply. The next best way, we will say, would be for each man, as he had occasion, to make one and, after having used it, turn it into the toolroom, and there would thus soon be a good supply. But would there? A majority of the hands would never make one; would not feel that they had time. These are of the sort of tools easily broken and hard to replace, and the work of keeping the shop supplied would fall on a few. Under these circumstances is it any wonder that when a man makes a reamer he sometimes puts it away for future use, and that after a time it comes about that a few of the men in a shop who are nearest each other and have the most in common come to know where they can perhaps find some tool they are in need of? Many of us have had the experience, at the toolroom window, of asking for something of a special nature that we knew to exist in that shop, and being told there was nothing of the kind there, then, on being a little more explicit, again hearing that they have no such tool and finally you remembering about where it was kept and getting what is wanted. Now, some of the men in the shop did not know of that tool, and others who did would not have been able to get it, as they would not have remembered so much about it or have been so persistent. Cataloging the tools, as W. speaks of, would do away with this difficulty, especially if the catalog was available to the men.

It has occurred to me since commencing this letter that one way out of this difficulty would be to have a special man whose business it should be when a special tool was wanted, arbor, reamer, counterbore, lap, boring tool, etc., to make it, and after it has been used, have it returned to him, he also to have access to and know what there was in the toolroom. The men would soon get so that when anything out of the ordinary was wanted they would go to him and he would know whether there was anything to suit the case in hand, perhaps he would show up what there was in stock, so the workman would have a chance to judge for himself, and then, if nothing could be found, have it made. I think I can see where such a department as this would soon come to be valuable in a shop. This plan could, and perhaps should, be comprised in the toolroom. As conditions are at present in many shops, the man in charge of this room does not understand the requirements of many cases that come to him, and many valuable tools are stored away on the shelves out of sight and are hardly ever used. Certainly a new man has to become an old one, in point of service, before he learns the resources of the toolroom. X.

Aluminum Vise Jaws — Trouble with a Taper Boring Lathe.

Editor American Machinist:

A kink which most machinists have not had a chance to try is the use of alumninum vise-jaws. They are much better than copper, in that the work is less liable to be marred, and if sheet brass is more expensive, area for area, than aluminum of the same gage, I should think the aluminum vise-jaw would be cheaper where it can be obtained. The sheet metal can readily be bent into the desired shape, but if cast aluminum is used, it will not stand much bending. I prefer the cast metal about ⅛ inch thick.

The following shows the trouble that may be occasioned by a lathe boring a little tapering, and also how I got out of the trouble: I had to put a 2½-inch reamed hole through a piece of machine steel 4 inches in diameter and 12 inches long. The reamer to be used on the job was of the expansion type with a pilot. I put the piece in the chuck and used the steady rest in the usual way, making the hole so that the pilot would fit about right, as I thought; but when I took the piece out of the lathe and tried to ream it, the pilot would go only about three-quarters of the way through. I drove a mandrel into the piece as far as it would go, and by running the dead center out pretty well I managed to get it on the centers. Then I took a cut over the other end for the steady rest, making it the same size as the place previously turned on the first end for the same purpose. I now put it in the chuck again, using the steady rest set as before. It was then easy to take out enough to enable the pilot of the reamer to go through. In less than an hour from the discovery of the trouble, I had as smooth and true a hole as a reamer will make. Z. Y. X.

Conciliation and Arbitration in the Coal Mining Industry.

We have before referred to the work accomplished by joint action of the Illinois Coal Operators' Association and the Mine Workers' Union of that State in avoiding strikes and lockouts—work which has seemed to us to be especially worthy of notice by those who on either side are interested in labor questions, because it is an example of the application of business principles and so far as possible of business methods of procedure to the relations between the miners and their employers, with a notable degree of success. At the recent meeting of the American Economic Association at Washington, Herman Justi read a paper under the title given above from which we extract some passages below. After referring to some of the difficulties in Illinois and among others to the fact that of the 40,000 miners employed in the State fully 40 per cent. are ignorant of the English language, the speaker said:

"I am expected to describe the system of conciliation and arbitration in use in the coal-mining industry of Illinois. There is not much to describe. There is not really much system about it. It is, after all, nothing more than a simple, effective, humane, common-sense arrangement of getting together on common ground in the

hope of reaching a fair understanding. It is nothing more nor less than a sort of balance-wheel of a great industry—albeit a device intended to keep the men at work long enough to enable them and their employers to think calmly and dispassionately over questions in dispute, certain that if this is done a fair adjustment of all differences will surely be made. In fact, our joint agreements provide that where differences or disputes have arisen 'the miners and mine laborers and parties involved must continue at work pending an investigation and adjustment.' At a period not very remote it was the universal custom to stop a mine whenever any dispute arose or when a demand was made, and idle it remained until the operator yielded or the miners were exhausted. This clause of the Joint Agreement is still violated far too often; but even so, it is a tremendous advance movement which has resulted in great saving of time and money to master and men alike.

. . . . . .

"While I shall try to plainly describe the plan of conciliation and arbitration pursued in Illinois, still it seems that what you most desire to know is not so much how differences and disputes are settled, but what it is that occasions these differences and disputes, and how to prevent them; for it is easy enough for fair men of average intelligence to determine upon a plan by which their difficulties may be settled, if they can only be brought to agree upon the real causes leading up to these difficulties. This is our objective point in Illinois.

"With scarcely an exception, every strike that has taken place in our time, even where there has been bloodshed and destruction of property, has finally been settled in friendly council. Our plan is to prevent these senseless and costly strikes, and the many differences and disputes arising between master and men which seem to place them in the attitude of enemies to each other, are settled in the same manner in which the most destructive strikes are finally settled, viz., by meeting in friendly council, where we try self-control long enough to enable us to say: 'Come, let us reason together.' This is, practically, all there is of the plan pursued in the coal-mining industry of Illinois, and of this plan to prevent strikes and to promote harmony and good feeling it can be said, at least, that it is the fairest thus far offered. Under it every inducement for doing right and of avoiding conflict is afforded, and its application proves that such a plan could only have been inspired by high and honorable motives. This honest tribute is due the coal operators of Illinois, who inaugurated the plan in their State, and to the officials of the mine workers who have cordially supported it. And yet the plan is not perfect; it is only a beginning, but it is a good and hopeful beginning, as I shall endeavor to show, and that the plan will be amplified and improved, I confidently believe.

. . . . . .

The idea, after all, is that these agreements are nothing more nor less than business contracts, such as business men generally enter into and perform every day of the year—contracts which must either be respected or repudiated. It is not necessary in other departments of business to establish special tribunals designed to adjust differences that grow out of contracts or agreements between business men and they should not be necessary in a large percentage of disputes growing out of these agreements between employer and employee. That is what the movement in Illinois is aiming at: viz., the application of business methods to business matters. If respected, the business idea is carried out; if repudiated, it is war.

. . . . . .

"When the disputes or differences arise the representatives of the United Mine Workers meet us by agreement and with them the miners and operators who are directly interested. Together these representatives of the two interests, without observing any prescribed form, meet and proceed to hear testimony, with a view of eliciting all the facts bearing upon the questions involved. . . . The main idea of these investigations is to bring out clearly the exact facts, and when this is done we have found that nearly all ordinary troubles adjust themselves before we have been a great while in session. The great advantage of such meetings is that it affords employer and employee an opportunity to meet upon common ground, and that long-standing grievances for which there had been little or no foundation can be brushed aside, and that the representatives of miners and operators alike can avail themselves of an excellent opportunity to explain the meaning of the joint agreements; the purposes they are intended to serve and the importance of complying with the spirit as well as the letter of such agreements.

. . . . . .

"Tact will prevent trouble. It is safe to say that there is really no valid cause for 95 per cent. of these differences and disputes being brought to the attention of the miners' officials and the operators' commission, and very often by the time these differences and disputes reach us, we find it necessary to deal with some offense growing out of contentions and bickerings over the most trifling matter. If, by some magic touch, we could burn into the brain of the mine manager, 'A soft answer turneth away wrath,' and into the brain of the miner, 'A polite request will obtain tenfold more than a rude demand,' we would soon be prepared to dispense with much of the tedious work now performed by those entrusted with the difficult task of preserving peace where it is threatened, or restore it where it has been broken. The work before us is, therefore, largely educational—a vast work to be performed by and at the expense of comparatively few men in the coal-producing industry of a single State. It would be idle to endorse the claim that our conditions in Illinois are ideal, but that there is a marked improvement and a hopeful outlook, no careful observer can deny.

. . . . . .

"Strikes, even when limited to a single mine and continuing for a short period of time, entail heavy loss on employer and employee. Three hundred dollars loss per day to the average coal-mining company and its men is a very low estimate. It is impossible to accurately determine the aggregate saving as the result of the Illinois Coal Operators experiment, but one-quarter million dollars would be a low estimate of what has been saved in the past year to miners and mine owners, and this experiment conducted at a trifling cost has not only brought mine owners and miners to a better understanding of each other, but it has brought the mine owners themselves together in a closer union and to a more just appreciation of each others' rights and to a recognition of the importance of organization among the employer class."

Again the Humbug.

It is a little surprising to us that, after the showing that has been made in our columns and elsewhere, of the doings of the "Southern Review of Commerce" it should still undertake to do any of its peculiar business with prominent machine-tool builders, and especially to make propositions to them which any intelligent schoolboy ought to know are humbug.

The Brown & Sharpe Manufacturing Company send us a letter received from this concern, asking them to correct an editorial article and to return it if found all right, at the same time offering in this letter to sell to the Brown & Sharpe Manufacturing Company copies of the paper containing the proposed article at 15 cents per single copy, or 100 copies at 12 cents, 250 at 10 cents, etc., on a decreasing scale to 1,000 or more at 8 cents per copy.

The article which the "Southern Review of Commerce" proposes to publish is as follows:

WE WERE RIGHT.

The Accuracy of a Former Recommendation fully Confirmed—Again Proven to be the best Machines.

"It is with some feeling of satisfaction that the 'Southern Review of Commerce' sees a vindication of former indorsements of worthy firms and meritorious articles. We have always given careful attention to inquiries received from subscribers, and to furnish them with reliable information on any desired subject free of charge. The 'Review' has the largest circulation of any trade journal in the country, and no other publication of its class could

afford to maintain such a large staff of experienced reporters to make these expensive investigations in the interest of its readers.

"Over a year ago we received inquiries in which we were asked to recommend the best Machines, and to state where same could be obtained. We fully realized the importance of the subject, and the confidence which would be reposed in our answer. We made a careful and thorough investigation locally, also referred the matter to our representatives in all the principal cities, and found that the Special Machinery and Tools made by the Brown & Sharpe Mfg. Co. of Providence, R. I., were conceded to be the best. We made editorial commendation accordingly.

"Only recently we received many similar inquiries from other of our readers, and to verify the correctness of our former recommendation, we placed the matter in the hands of our reporters and investigators who knew nothing of our former indorsement, and after the most exhaustive research they also have reported in favor of the Special Machinery and Tools made by the Brown & Sharpe Mfg. Co. of Providence, R. I., which proves conclusively that these machines are doubly worthy of adoption and use, and also that the trained reporters of the 'Review' never do anything by halves.

"We would advise all interested to address this company direct. They are well known for tact and enterprise, as well as sterling integrity, and their standing sommercially is of the highest order. Their business is conducted on a line that is pleasing to each and every customer, and promptitude is a special feature of their business methods.

"We have no personal interest in them or their machines, except to commend them as the best in strict accordance with our findings, and we are proud of the fact that there has never appeared upon these pages an unreliable or purchased indorsement."

This will readily be perceived to be the most arrant nonsense. No intelligent machinery man could think for one moment that such an endorsement by an absolutely unknown paper without any standing whatever could possibly be worth a single cent to the Brown & Sharpe Manufacturing Company or to anybody else. It is perfectly certain that the "Southern Review of Commerce" has no reporters or investigators or others upon its staff that know the difference between a milling machine and a steam hammer, or that are at all competent in any way to judge as to whether a machine is good, bad or indifferent. It is nothing but absolute, pure humbug from beginning to end, and we are surprised that this concern has the check to send propositions to any prominent tool builders, and still more surprised that the postal authorities allow such a transparent swindle the use of the mails.

Massachusetts Statistics of the Machinery Industry.

The Commonwealth of Massachusetts has published Part I of its Industrial Chronology for 1901, by Horace G. Wadlin, Chief of the Bureau of Statistics of Labor. It covers the year 1901 from January 1 to September 30. There is given a digest of business changes, also some tables of statistics which for machines and machinery show the following figures:

New establishments, 7; buildings constructed, 10; machinery added to plants, 6; other additions to plants, 7; addition of new class of product, 1; increased capacity of plants, 1; changes from private firms to corporations, 2; changes in firms, firm names, etc., 2; removals from one town to another in Massachusetts, 2; introduction of electric lighting and power into factories, 1; suspensions for vacations, 4; suspensions for stock taking, 1; suspensions on account of high water, 2; suspensions on account of repairs and improvements, 1; suspensions on account of accidents, 2; suspensions on account of dull trade, 0; suspensions indefinite as to duration, 1; suspensions on account of retirement from business (no successor), 1; sales of plants in whole or in part, 7; sales of plants to industrial combinations, 2; fires, 9; deaths of manufacturers, 2; new corporations, 6, with $3,555,000 aggregate capital.

Friction of Lubricating Oils at High Temperatures.

From an article on the above-named subject by Sigmund Kapff in the "Zeitschrift des Vereines deutscher Ingenieure," the following abstract has been made for the Institution of Civil Engineers, London, England:

"In a paper published on this subject by Thurston in 1899, it is stated that the coefficient of friction of lubricating oils decreases as the temperature rises to a limit of about 82 degrees Cent., from which it is concluded that heating of the bearing to this degree must not be regarded as harmful and that a hot bearing need not be cooled unless its temperature exceeds 100 degrees Cent. The author draws attention to the fallacy of these views which only take account of the frictional resistance, and which, even if this latter were the principal factor to be considered, would not hold true generally. Leaving aside the question of the danger of a hot bearing, the small saving of energy due to the low value of the coefficient of friction of the oil would be far more than counterbalanced by the amount of heat wasted in keeping all bearings at a temperature of 82 degrees.

"Two causes contribute to the heating of a bearing. (1) A quantity of energy, varying widely with the consistency of the oil, is expended in overcoming the internal friction (cohesion) of the oil and is partly converted into heat. The amount of heat produced in this way is relatively small, for, experimenting with a 100 horse-power engine and a good lubricating oil, the author finds the temperature of the bearing at the end of the working day to be 35 degrees Cent., while with more viscous oils it reaches 38 and 40 degrees and with a cylinder oil 46 degrees. (2) An oil possessing small adhesion may, either by pressure or high speed, be removed from contact with the rubbing surfaces, which may then be raised even to a red heat. There can hence be no doubt that something is wrong with a bearing which becomes heated to a temperature of 80 degrees; either the oil used is bad, or too little of it is employed, or possibly the bearing is dirty or otherwise out of order.

"The author goes on to consider the conditions to be fulfilled by a good lubricating oil, which are as follows: (1) It must be free both from acid and solid particles and must not resinify or become acid, while its flash point must be suitable to the purpose for which it is intended; (2) it must have a suitable adhesion, and (3) at the temperature at which it is used its frictional resistance must be as small as possible. The ordinary method of judging of the value of an oil from its price, appearance, specific gravity and viscosity is entirely fallacious, since none of these factors have any bearing on the good or bad lubricating properties of an oil. A rapid method of examining lubricating oils is described by the author."

"A Letter From an Engine Builder's Customer."

At a recent dinner held in New York and attended by engineers, a manufacturer of engines in Canada read a letter received by him some time ago from a French-Canadian customer. It is a gem in its way:

"Mr. ———.

"Dear Sir: Le engine which I procur from you for drive thrash machine he is all rite correc and he work much more quiet as thrash machine all but one thing which is place in wheel and is mak for drive le valv which work front and back for admit le steam out an in le cilindar. My brother Philip who is certificat engineur at Montreal he call hit le governeur an he cant mak hit work to. Le engine he run correc all day like clock but when we stop him by shut trotle valve le governeur he mak some bad noise more worse as thrash machin. Mon frere Philip he try tight le spring but wich hit mak le engine go like two forty horse an cause him run fas then slow lik winmill. Nex mon frere he loose le spring—mon dieu—I think that time le governeur he smash his self in little piece. All my man come scare and all these man have stack hees dud til engine be fix. S'il vous plait send explanation how repair those trouble an mak me satisfy in al respec.

"Your frien ———."

Published at 218 William St., New York, every Thursday by the

American Machinist Press.

[INCORPORATED.]

Also published at 34 Norfolk St., Strand, London, W. C.

Correspondence on mechanical subjects solicited. Name and address must always be given—not necessarily for publication.

Address all business communications to the American Machinist Press. Matter for reading columns may be addressed to the Editor.

Subscribers can have address changed at will. Give old and new addresses. Date on wrapper denotes end of month in which subscription expires.

Subscription Price:

$4 per year, postage prepaid, to any post office in the world. No back numbers beyond current year. For sale by newsdealers, generally.

European subscriptions served by the AMERICAN MACHINIST CO., LTD., 34 Norfolk St., Strand, London, W. C.

Entered at New York P. O. as mail matter of the second class.

Cable address, "MACHINIST," N. Y. Lieber's and A B C Codes.

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The index for the 1901 volume will be enclosed with the number for January 9 to all mail subscribers. It will be sent also to all others who ask for it and send addresses.

Our Machinery Trade with Russia.

There is evidently someone in Washington who considers it to be his mission in life to demonstrate by statistics of trade that the sugar controversy with Russia did no harm to our machinery trade with that country. Apparently this interesting person thinks that an American machinery builder will go by the figures thus presented through the medium of the press despatches rather than by his order book, but we don't believe it. The latest effort of this before-mentioned interesting individual is devoted to showing that our exports of machinery to Russia have not been diminished by the increased duties levied by Russia as a result of Secretary Gage's sugar decision. This might have been all right if he had stopped at that, but he goes on to be more specific and—falls down, because he instances agricultural machinery particularly as having gone from here to Russia in undiminished quantities in spite of the action of Russia without mentioning the further and most important fact that Russia some time ago removed all import duties from agricultural machinery, so that for some little time before the sugar controversy and since as well agricultural machinery has gone into Russia absolutely free of import duties, no matter what country it may have been made in; consequently there is no reason whatever why American agricultural machinery should not have gone to Russia in undiminished quantities.

But to know this will be small consolation for those whose business has been interfered with by the sugar trouble. It is folly to try to convince American machinery builders by statistics that an action by which Russian import duties are made much higher on American machinery than they are on machinery imported from England, France or Germany does no harm to American machinery builders. They will not believe any such nonsense.

Some Jobbing Shop Problems.

A friend who runs a jobbing shop says there are some points about the business that he despairs of ever learning. Suppose, for instance, a man comes in with a job of work which is fine and demands the highest order of skill the shop commands. Suppose the best machinist is put on to it and his time is charged for at a rate sufficient to pay his wages, cost of the portion of the shop and equipment he uses with something, but not much, over for cost of supervision. Suppose that during the progress of the work an expensive piece of it is spoiled by a mistake or by an accident, whose loss should this be? Our friend says his customers, when they know, as they sometimes do, that such a thing has occurred always insist that they ought not pay for the work done on the spoiled piece. In support of their contention they say that they agreed to pay so much per hour for *skilled* labor, that if the man had been skilled as he ought to have been, the mistake or accident would not have happened and therefore there ought not to be any charges for the spoiled work. In vain does our shop-owner friend point out that such things are inevitable and a necessary element of the cost of machine construction that must be provided for and paid for by somebody; that the man sells only his skilled labor at so much per hour and guarantees nothing—the courts having in fact repeatedly decided that the cost of such mistakes cannot be taken out of a man's wages nor his wages docked on account of them; that nothing more ought to be required of the shop than it, or shops generally, can command, *i. e.*, good, careful, skilled men, good tools and conscientious service. It avails nothing, the customer kicks, and if his custom is valuable he has his way, and if the proprietor has good luck the customer pays the bill afterward in some other form, the same as the mercantile house paid for its traveler's new overcoat, which, though it did not appear in his expense account, was there all the same. On the other hand, if the proprietor's luck is not so good he simply loses the amount and charges it up to profit and loss. Now what he wants to know is what is the right and wrong of this matter and how may trouble of this kind be avoided?

Again suppose a good man in the course of the work breaks a tool. It may be a new and good twist drill of large size, which, being pushed too hard, broke. Now if the man using this drill took pains to feed it so mildly that there would be a dead moral certainty that it could not possibly be broken, the unnecessary additional time taken to do the work might easily amount to the cost of a dozen or more of such drills. In fact, the occasional breakage of a drill in service is assurance and perhaps the only real assurance that work is being one at as rapid a rate as circumstances will permit. But the customers always kick at paying for such drills or for taps or anything else, though of course in the end it is obvious that the customers collectively must pay for all such breakages and all other necessary expenses of the shop or it will go out of business. The fact is, of course, that in the long run those who have machines built or those who finally use them must in the end pay for all the costs that enter into their construction plus a reasonable and fair profit for those whose capital is risked in the business. But the trouble seems to be in a jobbing shop that though the customer can be made to see this as an abstract proposition, he still insists that he himself will not pay for time

spent in making parts that are of no use to him and that do not become parts of his machine, and he will "see them further" before he will pay for any broken tools. And so our friend is puzzled and wants to know how others older and wiser than himself manage these things.

Two Mistakes.

A recent publication of the Library Bureau, whose New York office is at 377 Broadway, and which is devoted to setting forth the advantages of the card index for business correspondence, makes use of an expression which would be well worth heeding in many manufacturing establishments. This expression is: "There are two common costly mistakes in business—wasting fine brains on routine work; trusting fine work to routine brains."

Personal.

Ezra D. Groves, head draftsman at the Taft-Peirce Machine Works, Woonsocket, R. I., has resigned. He has received several offers, but for the present has declined all, and will spend the winter in the South.

William Deering, founder of the great harvester concern at Chicago which bears his name, has retired from active business, leaving the company to be guided hereafter by his sons, Charles and James Deering, and his son-in-law, Richard F. Howe.

An English correspondent, who says he understands that there is a way of hardening and tempering clock pinions so that they will not be sprung out of shape, writes that he would like to know if any of our readers have had experience in doing such work and can help him. His pinions are of steel with cut teeth from 2 to 3 inches in length.

A correspondent sends in a newspaper clipping containing a despatch from Canaan, N. H., describing a fine new sawmill which had been erected and fitted with the latest and most improved machinery. When all was ready to turn steam on and go to work, it was found in the language of the despatch, that "all the saws, planers, belts and wheels in the building commenced moving backward. Investigation finally showed that the engine was fitted with an *undershot flywheel*, the action of which naturally brought about exactly the opposite effect of an ordinary overshot wheel, but which in the assembling of the machinery had been overlooked." Thus we see that some facetious machinist has again been "stuffing" the reporter.

The Osborn Oil Company, of Cleveland, Ohio, state that "1½ barrels of Extra No. 1 lard oil were left over from a carload," and are therefore offered at a reduced price. They send this proposition to the Bagley & Sewall Company, of Watertown, N. Y., who inform us that the Osborn Oil Company seems to be unfortunate and that it has their sympathy but not their dollars.

Technical Publications.

We have received a small book illustrating the plant and some of the product of Ludwig Loewe & Co., Berlin, Germany. Following a few pages of descriptive matter, there is a birdseye view of the extensive works; then pages of illustrations of the tools, small and great, that are made there; of the various shop departments; of groups of visitors, etc. The illustrations are beautifully executed and the book will be especially interesting as a souvenir to those who have visited the works. Copies of the "album" were handed to the members of the "Schiffsbautechnische Gesellschaft" who visited the works a short time ago.

"Manual of Instruction in Forge and Machine Work; with Figured Drawings of Methods and Exercises Used in the Fowler Shops of Kansas University." By Frank E. Ward, superintendent and instructor in machine work and mechanical methods and practice. 86 pages, 4x 6½ inches.

This little manual seems to give very complete instruction in the very complete series of "exercises," or things to be done by the student in the shops of the institution to which it applies. Accurate and carefully figured sketches are given of the various pieces of work, and the student who goes through the course cannot fail to acquire much of both knowledge and skill in the lines followed. That he will be a complete and finished workman we are not prepared to say, as that is a product from which the element of time cannot be eliminated. The address of the author is Lawrence, Kansas.

"Engineering Periodicals and the Card Index." By H. W. Hibbard. Eleven 6x9-inch pages.

This pamphlet contains the matter of an address before the Students' Mechanical Engineering Society at Cornell University. We have been through it with a view of publishing an abstract of its contents, but find that, while it is too long to be published entire, it is too good to be cut in pieces by the editorial scissors. Moreover, this is really unnecessary, as Professor Hibbard informs us that it is for gratuitous distribution, provided postage stamps are enclosed with the request.

The address is a highly appreciative statement of the value of technical papers and explains the author's method of culling the cream from them as well as of indexing important articles by the card file. Those who are not familiar with the extent of the usefulness of the card index will find here many suggestions which no young embryo engineer can afford to disregard.

"Winke für Erfinder. Die angeben, welche Erfindungen verlangt werden, und wie sie zu vervollkommnen und zu entwickeln sind." By Ingenieur Dr. Robert Grimshaw. 132 4x5½-inch pages. New York and Hannover: Practical Publishing Company. Price, 3 marks.

Within the covers of this little book are collected in a German version numerous "Points for Inventors" by Robert Grimshaw, some of which have appeared in different American papers. His object is to warn the inventor away from fields that offer little hope of remuneration and to indicate the lines along which improvements are needed. The volume is therefore to a great extent a catalog of desirable inventions, which are classified under a dozen or more industries. There are also chapters on the development of inventions, sale of patents, etc. As there are many people in the world who are sure that they could write if they only had something to write about, there are also many who could invent anything if they only knew what to invent. This book seems to contain just the information those people are in need of.

"Practical Marine Engineering." By W. F. Durand. 706 6x9-inch pages with 314 illustrations. Marine Engineering, New York. Price $5.

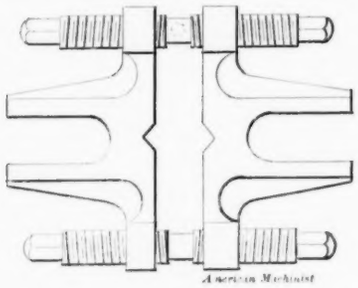
In the language of the preface, this book has been prepared "to provide help for the operative or practical marine engineer . . . who may wish some simple and fairly complete presentation of the subject from the practical standpoint." The scope of the book may be gathered from some of its chapter headings, such as Fuels, Boilers, Marine Engines, Auxiliaries, Operation Management and Repair, Valves and Valve Gears, Refrigeration, Electricity on Shipboard. At the end eighty-six pages are devoted to Computations for Engineers. The book is packed with information from cover to cover, and while devoted to marine steam machinery, the stationary engineer will find it of almost as much value as the marine engineer. All the essential features of the propelling machinery of a ship with the auxiliaries are described and fully illustrated, the engravings being from representative examples of recent practice. In addition to descriptive matter proper, such broad subjects as Boiler Economy, Engine Economy, Coal Consumption, Strength of Boilers, Loss by Blowing Off, Gain by Feed Water Heating, etc., are discussed in a manner which, while within the comprehension of beginners, will yet be found of value by many who are not beginners. We know of no descriptive treatise on steam machinery that compares with this in value.

Some New Things.

Perry Ransom, of Oshkosh, Wis., has brought out an improvement in emery grinders wherein there is attached to the hood an emery dresser in such a way that when not in use a simple upward movement of the handle takes it out of the way and when it is to be used it is instantly available by simply bringing the handle down until the dresser contacts with the wheel. This does away with the necessity of putting on an attachment when the wheel is to be trued and enables the operator to have the wheel always true with very little trouble.

A BALANCED LATHE DOG.

The cut shows a lathe dog recently patented by Milton B. Hill, Worcester, Mass. It has the self-evident merit of being al-

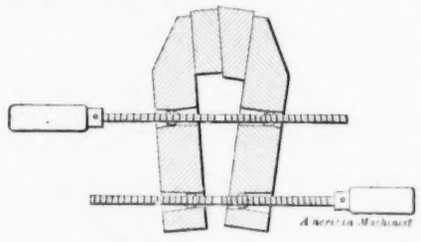


A BALANCED LATHE DOG.

ways balanced if two driving studs are used in the face-plate in connection with it. The operation of opening or closing the dog must be a slow and tedious one from the necessity of turning both screws. It is suggested that the middle portion of each screw might be enlarged and knurled so as to be turned quickly with the thumb and finger before the final tightening.

IMPROVED PATTERNMAKER'S CLAMP.

The cut shows an improvement upon the familiar wooden clamp or "handscrew" recently patented by Hans Jorgensen, Chicago. Each member of the clamp is bored with two cross holes entirely through from side to side, and in



IMPROVED PATTERNMAKER'S CLAMP.

those holes are placed round pieces tapped crosswise in the middle for the screws. The screws are of metal with right and left threads and the handles are pinned or otherwise fastened on. The holes are beveled out, as shown, to allow the screws to clear as the nuts swing. The adaptability of the clamp in comparison with the older type, in which it was necessary to keep the jaws parallel, is evident. The metal screws should last longer than wooden screws, and neither screw nor nut can get out of place.

A FLUX FOR BRAZING.

A recent United States patent granted to Friedrich Pich, of Friedrichshagen, Germany, seems to convey at least a valuable suggestion concerning the use of fluxes in the operation of brazing. The following is from the specification of the patent referred to:

"Among fluxes in use for hard-soldering and brazing borax has hitherto been best, because, unlike other fluxes, it is equally applicable to all cases of brazing and because it surpasses all other materials in dissolving different oxides. The use of this salt would be universal were it not for the fact that during the expulsion of its water of crystallization by heat it intumesces so strongly that it is shifted from the place where it has been put and often falls, together with the spelter mixed with it, into the fire. For this reason the operator must start with an excess of the flux and must add more thereof during the brazing operation. Much material and labor would be saved, therefore, if this objectionable property of borax were set aside. A further drawback to the use of this salt is that the surfaces to be brazed must be carefully cleaned before the borax is applied, and even contact with greasy or dirty fingers frequently spoils the surface for brazing. By this invention the foregoing objections are overcome by substituting for borax constituents which form sodium borate during the brazing operation. Such constituents are boric acid and a sodium salt, like sodium carbonate. The action of the mixture containing sodium carbonate is as follows: When the surface to which the mixture has been applied is heated, or even if the mixture is applied wet, the sodium carbonate cleans the surface from grease and the like and then frits itself on to the part thus cleansed. The boric acid tends to intumesce somewhat; but being intimately mixed with the sodium carbonate it is held in place thereby. When the mixture is further heated, the carbon dioxide is evolved and sodium borate is formed. The latter is anhydrous under these conditions and does not intumesce. The dissolution of the oxides from the metals to be brazed is very energetic and rapid. In what has been said it is implied that the proportion in which the constituents are mixed is such that sodium borate is formed on heating the mixture; but either constituent may be used in excess of this proportion without affecting the invention. An addition of sodium chloride to the mixture enhances the effect by rendering the molten mixture more fluid."

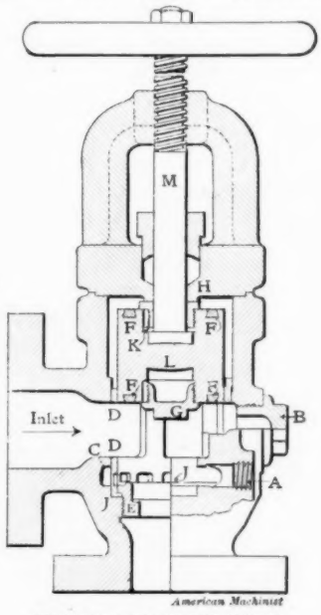
The following is the "claim" of this patent:

"1. A flux for brazing containing sodium carbonate and boric acid intimately mixed together, substantially as shown and described.

"2. A flux for brazing containing sodium carbonate, boric acid and sodium chloride intimately mixed together, substantially as shown and described."

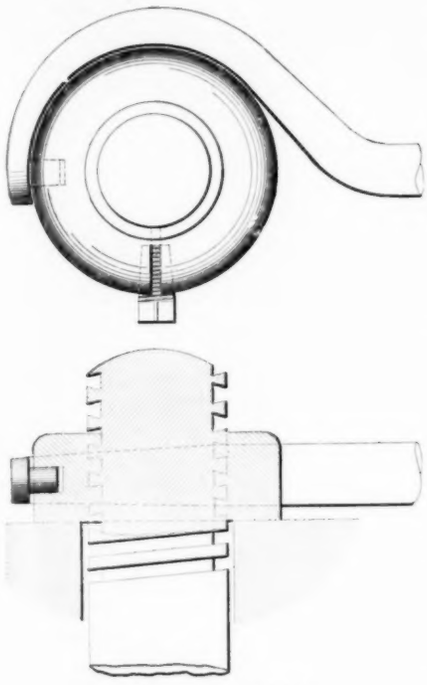
THE DURO BLOW-OFF VALVE.

The valve shown in the cut embodies a simple but ingenious device for circumventing one of the most serious and persistent troubles of the engineer. It is a blow-off valve with a self-cleaning seat. In general appearance the valve resembles an ordinary angle valve with inlet at the side and outlet at the bottom. There is a small steam inlet *A* at the back which connects with an annular passage *C*. The inserted brass casing *D* has a circular slot *J* cut into the side just below the level of the seat *E*. The steam inlet *A* admits steam to *C* and *J*, and, discharging from the latter, it blows across the seat and will clean off anything that may have settled there. In closing the valve the disk is screwed down in the usual manner. The edge of the disk passing the lower edge of the casing *D* cuts off a great deal of the flow of water, sediment, etc. The valve in the pipe leading to *A* should now



THE DURO BLOW-OFF VALVE.

be opened, admitting steam to *C* and *J*, blowing off the entire surface of the seat *E*. The disk, continuing the closing movement, cuts off the steam from inlet *A* as well as the blow-off from the boiler. The valve in the pipe leading to *A* may be left open at all times, as the disk of the blowing-off valve would keep this outlet closed. The disk is reversible, giving two faces equally serviceable; they can also be easily renewed by refilling with Babbitt metal. The seat ring *E* and casing *D* also can be renewed at slight cost, as they are made interchangeable. The valve is made in three sizes, with flanges or screw ends, by The Lunkenheimer Company, Cincinnati, Ohio.



A DOVETAILED THREAD.

Mr. Charles Fischer, 446 West Thirty-third street, New York city, has recently been granted a patent on what seems to be a new form of screw thread. This thread is, as a shop man would say, "worse than square." That is, it is dovetailed, the cross-section of the thread being narrower at the bottom than at the top in both the screw and the nut. The result of thus shaping the threads is that they interlock and that, for instance, a half nut is held securely to the screw. The inventor proposes, among other things, to make use of such a thread in securing the two halves of a pulley to a shaft. A curious feature of this thread is that by splitting a nut on one side and fitting into the split a taper screw the nut can be locked upon the screw by spreading it; that is, by opening the nut instead of by clamping it, as would be necessary in the case of an ordinary thread. At first it might be thought that a nut with such a thread could not be tapped, but it is readily done by a tap having its threads chased parallel—*i. e.*, the same diameter from end to end, but tapered on top.

IMPROVED GRINDER.

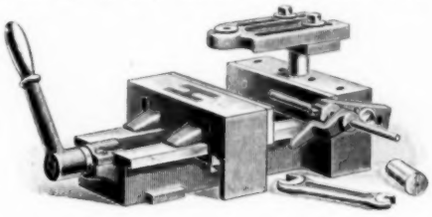
The George Gorton Machine Company, of Racine, Wis., recently added a device to their grinding machine illustrated at page 991, by which a diamond holder is always in position to be brought up to the wheel at a moment's notice when it requires truing. It is attached to a corner of the work-table, so that it is moved across the face of the wheel by the table movement.

THE STEARNS MOLDING MACHINE.

The makers of the molding machine shown in the half-tone being extensive hardware manufacturers, first devised this machine for use in their own foundry, where its value was first demonstrated. The machine is so simple as to require no explanation. One movement of the lever performs the double operation of bringing the presser head into position and of pressing the mold. The lever is adjustable for length to suit different conditions, and the leverage is so advantageously arranged that a short movement of the lever does the work. Flasks of any ordinary type, either wood, solid iron or snap, may be used. The machine is made by E. C. Stearns & Co., Syracuse, N. Y.

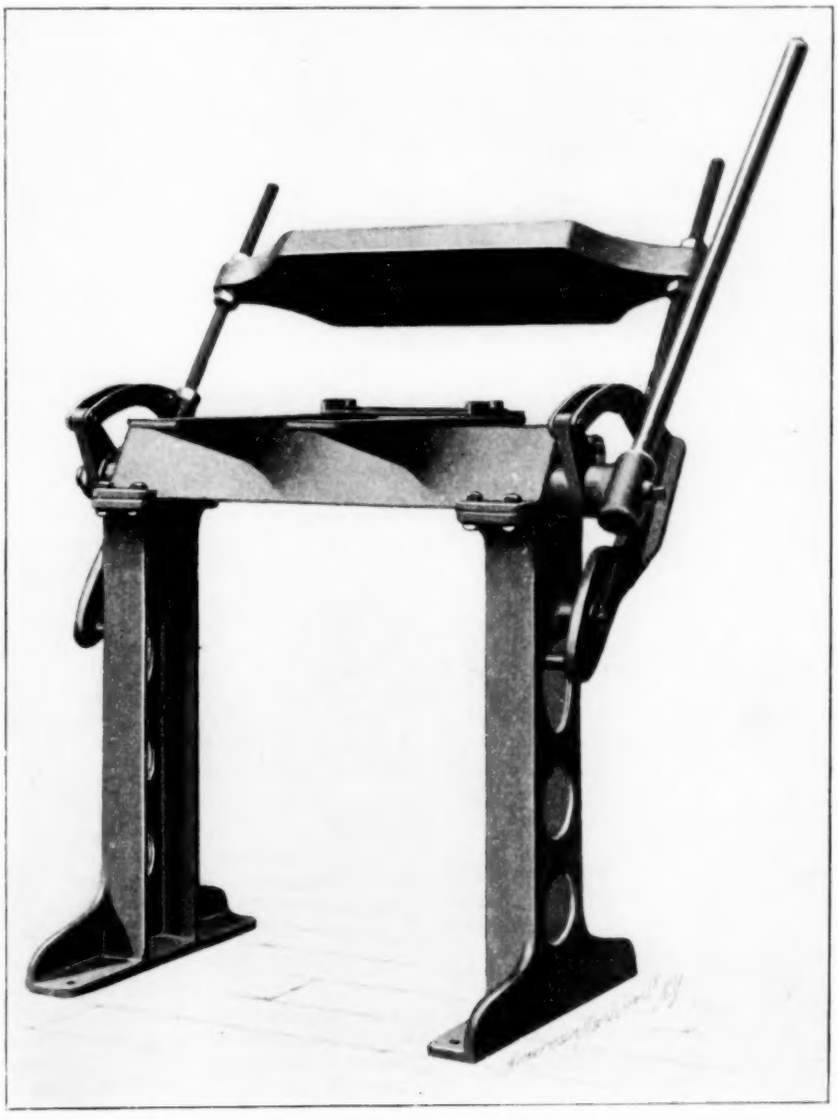
A DRILL PRESS VISE AND JIG.

The Graham Manufacturing Company, of Providence, R. I., is manufacturing a vise especially adapted for use on a drill press, and though it is intended to be used as a plain vise especially adapted to facilitate the work of fastening and removing work from the drill press table, it has additional means of supporting a drill bushing in any desired position, so that where a number of duplicate pieces are to be drilled they can be placed in the vise against an adjustable gage and drilled through the bushing without being laid off; thus of course greatly facilitating the operation. The construction of the vise will be readily understood from the engraving. The bushing for the drill is adjustable in any direction, and the plate



A DRILL PRESS VISE AND JIG.

which holds it is ordinarily fastened direct to the vise, though it can be raised above the vise by the piece shown in use in the engraving, which is clamped at any desired hight by a clamping device not shown. The gage and the bushing can be set to a sample piece and, after that, duplicates drilled the same as in a regular jig.



THE STEARNS MOLDING MACHINE.

Commercial Review.

NEW YORK, Saturday, Dec. 28.

MACHINE TOOL AND OTHER NOTES.

Despite the Christmas season the demand for machine tools has held up very well. While there has of course been a tendency to delay large work, as shown by the fact that the big railway-shop deals are still hanging fire, trade of an ordinary character continues in good volume.

The Niagara Falls Power Company has awarded contracts for five more turbines and generators for the second wheel pit, which will give this new pit eleven in all, bringing it up to its maximum capacity of 55,000 horse-power, a total of 105,000 horse-power for the two pits.

The doubling of the Carnegie armor-plate works calls for some heavy machinery, including, it is said, a duplicate of the 12,000,000 pound hydraulic press.

As a result of the cut in copper prices, brass goods will naturally be affected if the present copper quotations continue. Brass manufacturers are about to hold a meeting at which the matter will be considered.

Machine tool purchases by the Navy Department have been running light for a long time past, except for installation on the Pacific Coast. An authority in this line of trade states that from now until the first of next July, when there will be a new appropriation, buying is likely to be limited chiefly to that of an emergency character.

The Navy Department will open bids January 14 for furnishing supplies for the Puget Sound Navy Yard. Among the items are the following: The installation of a steam-heating system in the general storehouse; locomotive steam crane; 5 horse-power motor; stationary stop engine, with automatic governor; back-geared screw-cutting engine lathe; modern tool-room lathe with compound rest; 16-inch triple quick-return crank shaper; combination radial drill; combination punch and sheathing machine; 14-inch sensitive drill with square and box tables; power grindstone complete with stone dressing attachment; bench emery grinder; twist-drill grinder for grinding drills from ⅛ to 2¼ inches.

The National Rolled Steel Car Company, which was incorporated, with $1,000,000 capital stock, under the laws of West Virginia, several months ago, and which has been perfecting plans for building works in the Pittsburgh district, is about ready to award contracts for the construction of its new plant which will employ over 1,000 men. The buildings and machinery have been specially designed, and bids for much of the work have been called for. J. D. Carnahan, president of the company, states that the location will not be made public for a short time. It is said that an order for 500 cars has already been placed with the company.

Now it is reported that the Pennsylvania Railroad is to build a $1,000,000 car-wheel plant at Altoona, Pa.

Improvements, as we recently predicted, are to be made at the Rogers Locomotive Works in Paterson, N. J., which have been taken in hand by a new company to be operated again. Ground has already been broken for a new boiler shop which is only the beginning of the improvements, for, it is said, the works will be doubled in capacity so as to employ 2,500 men instead of 1,250. The Hocking Valley Railroad Company has placed an order with the Rogers company for twenty consolidated freight locomotives.

Browne & Frothingham, 32 Broadway, New York city, have opened a department for the export of machine tools. It will be under the supervision of A. M. Fisher who has just returned to New York after three years spent in Japan, where his entire attention was devoted to this line.

Another addition, 50x160 feet, is to be built to the Harrisburg Foundry & Machine Works, Harrisburg, Pa. Among recent sales of the company is that of two 150 horse-power engines for the Pennsylvania Steel Company. This will be used to drive Eddy generators.

A new concern called the Pneumatic Tool Company, Ltd., has been incorporated with a capital of $100,000 to manufacture and sell pneumatic tools and appliances. The incorporators are E. W. Irwin, of 120 Liberty street, New York, and others. The new company has not yet organized and its business arrangements have not yet been fully matured.

A copper refining plant is being built at Sawyers, N. J., by the De La Mar Copper Refining Works. A machine shop equipment for use in connection with the same has recently been purchased.

CONDITIONS OF AMERICAN MACHINERY TRADE IN SPAIN.

J. F. Villalta, dealer in American machinery exclusively, at Barcelona, Spain, is on a brief American visit and has called at the office of the "American Machinist." Mr. Villalta has been in his present business eight years. He is doing missionary work and against serious obstacles is trying to popularize American machinery in Spain with a view not so much to present results as to future ones, concerning which he is sanguine. The obstacles are not from prejudice against American machinery on the part of Spanish buyers—for contrariwise they seem to prefer it to any other—but from the expenses attendant upon importation. There is, for one thing, a higher duty on American tools than on those from European countries. On American machine tools, as we understand from Mr. Villalta, it is 28 pesetas ($5.60) per 100 kilos. (220 pounds) gross, amounting to somewhere about 20 per cent. ad valorem. On small tools it is 75 pesetas ($15) per 100 kilos. gross, amounting to more than 25 per cent. ad valorem.

Another serious item of expense is the freight. Since there is inadequate steamship communication between Spain and America, much of the merchandise comes via Havre, France, thus adding to the ocean freight the expense of the overland journey. Mr. Villalta states further that the boxing of machinery is apt to be unnecessarily heavy, while insufficiently protective. Sometimes the crates add from 30 to 50 per cent. to the weight of the machines and in the clumsy cases of this sort the machines have been broken quite as frequently as in lighter ones, because they are faultily packed. The cases ought to be made to fit the machines snugly, and the small parts should be removed and packed separately.

Again, the expense of import trade is greatly enhanced by the high rate of exchange, amounting to 50 per cent. What is needed is a reciprocity treaty, by which not only would the duty on American machinery imported into Spain be reduced but the exportation of Spanish products to America would be facilitated, which would lead to a lower exchange rate.

Spanish industry is now prospering. There is much electrical work, for instance. Electrical shops are to be found in every district of Barcelona. Dynamos and motors are built in Spain, but sometimes with archaic tools. Mr. Villalta mentions as examples of the appliances used an English lathe seventy years old and a drill turned by hand.

Spain is a great iron ore country and considerable pig iron is produced. Recently the iron manufacturers there have been infected with the consolidation idea and have formed a trust.

Coal costs from 25 to 75 pesetas ($5 to $15) a ton. Some of it is imported and some of it taken out of the ground in the country. The methods of coal mining in Spain are primitive; the pick-axe still governs. Mr. Villalta is conducting a propaganda for agricultural machinery and intends to work up the market for American threshing machines. Those at present in use are chiefly of English make.

Among other points, Mr. Villalta mentioned that imitations of American tools made in England, as well as on the Continent, are being sold in Spain. Sometimes the smaller ones are deliberately packed so as to create a deception.

CHICAGO MACHINERY MARKET.

As the old year goes out, it leaves the Western machinery trade more satisfied with recent business and more hopeful for the future than did its predecessor under similar circumstances. Optimistic reports have become monotonous if not tiresome, and no changes from the uniformly beatific conditions can be noted. Holidays have had their influence, but no one grieves thereat. In machinists' supplies, December has proved one of the best months of the year, though most of the business was closed during the first half of the month. One of the largest

sellers of emery wheels in this territory booked so many orders during the first fifteen days of the month that he has ever since been kept busy filling the same. With him the last half of the month has been active, though mainly by way of clearing up this accumulated business. Two manufacturers who recently established branch houses here—L. S. Starrett Company and the Cleveland Twist Drill Company—in adjoining warerooms, report a most gratifying condition of trade, better than anticipated. Equally flattering statements are heard generally. Buying during the last half of the month is restricted to actual needs, but the shops seem to be running without diminution and the volume of supplies needed is increased week by week rather than decreased, for there is constantly coming into activity new shop capacity. C. H. Besly & Co. have just completed an addition to their plant and are equipping it with machinery, besides displacing the old machinery with new. Expansions of that kind are so common as to be almost the rule.

Equally as notable as this voluminous present trade is the outlook for the new year in the matter of machinists' supplies and fittings. One customer of a supply house remarks that he has booked enough orders for hardware and building specialties to keep his plant in continued operation for six months and he thinks he sees twice or three times that amount of business in sight, if he cares to go after it. Consequently he is inclined to contract for his supplies for a considerable time ahead. There are many in the same sanguine mood, so makers of supplies are closing many orders for future delivery. It is the trade actually in sight, not hypothetical business, that gives rosy color to the future.

About the only unfavorable condition is that in pulleys, hangers and some other foundry products for machine-shop use, an inferior article is being turned out somewhat more commonly than before in a long time. This is due to the extreme scarcity of coke and the moderate scarcity of pig iron, the latter threatening to become more severe. Foundries are obliged to shut down or to use material that under normal conditions they would unhesitatingly reject.

Quotations.

NEW YORK, Saturday, Dec. 28.

Pennsylvania Foundry Pig Iron, Jersey City delivery:

No. 1 X	$16 65 @ $17 15
No. 2 X	16 15 @ 16 65
No. 2 plain	15 65 @ 16 15
Gray forge	15 00 @ 15 25

Alabama Pig, New York delivery:

No. 1 foundry, or soft	15 75 @ 16 50
No. 2 foundry, or soft	15 25 @ 15 75
No. 3 foundry	14 75 @ 15 25
Foundry forge, or No. 4	14 25 @ 14 75

Bar Iron—Base sizes—Refined brands, mill price on dock, 1.68c. in carload lots. From store, 1.90 @ 1.95c. in small lots.

Tool Steel—Base sizes—Good standard quality, 7c.; extra grades, 10c. and upward.

Machinery Steel — Base sizes — 1.95 @ 2.00c. from store.

Cold Rolled Steel Shafting—Base sizes —From store, 2¼ @ 2½c.

Copper—Lake ingot nominally 13c.; electrolytic, 12⅞c.; casting, 12½c.

Pig Tin—In 5- and 10-ton lots f. o. b., New York, 23¾ @ 24c.

Pig Lead—For wholesale lots, 4c., with .02½ @ .05c. extra for carloads.

Spelter—4.30 @ 4.35c. for ordinary quality, New York delivery.

Antimony—Cookson's, 10¼ @ 10½c.; Hallett's and U. S., 8¼ @ 8⅜c.; Italian, 7¾c @ 8c.

Lard Oil—Prime City, 82 @ 83c. in wholesale lots.

Manufacturers.

The Buckeridge Pump Company, Wichita, Kan., will add to its capacity.

The village board, Booneville, N. Y., has selected a site for an electric plant.

Keeler Brass Company, Grand Rapids, Mich., will build an addition to its foundry.

The Louisville & Nashville Railroad will, it is said, erect a repair shop at Selma, Ala.

The J. Nells Lumber Company, of Sauk Rapids, Minn., will add a new band mill, etc.

Ground has been broken at Warsaw, N. Y., for the Wi...inson Plow Company's buildings.

The Alma Portland Cement Company, of Philadelphia, will rebuild its mill at Wellston, Ohio.

A disastrous fire occurred recently in the plant of the Brooklyn (N. Y.) Cooperage Company.

The Trumbull Electric Company, Plainville, Conn., is making plans to raise its factory one story.

The Wm. Skinner Manufacturing Company, Holyoke, Mass., silk goods, braids, etc., will build an addition.

Plans for improvements to the Queensbury Mills, worsted yarns, Worcester, Mass., are being considered.

The Niagara Electro-Chemical Company, Niagara Falls, N. Y., has commenced the erection of an addition.

The Trumbull Electric Company, Plainville, Conn., intends to erect another story on the present factory building.

Machinery, etc., has been damaged by fire at the oil refinery of the Marion Refining Company, Brooklyn, N. Y.

A statement is made that the Seaboard Air Line's shops at Raleigh, N. C., will be restored and fitted with machinery.

M. J. Gleason will shortly open a brass foundry at Richmond, Ind., for the manufacture of chandeliers and other fixtures.

The Wabash Screen Door Company, of Chicago, Ill., whose big factory at Rhinelander, Wis., burned recently, will rebuild at once.

The erection of an addition to the plant of E. M. Freese & Co., Galion, O., manufacturers of brick and tile machinery, is contemplated.

The American Steel & Wire Company is planning to make several additions to its south works at Quinsigamond, Worcester, Mass.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Gear Wheels, gear cutting. Grant; see p. 18.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Punches & dies. Wal.M.Wks., Waltham, Mass.

Wanted—Improvements in grinding machinery. Address Box 1435, Providence, R. I.

Light and fine mach'y to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Book "Dies and Diemaking," $1, post paid. J.L.Lucas, Bridgeport, Ct. Send for index sheet.

"Brandt's Triple Expansion Gaskets" are the best for boilers. Randolph Brandt, 38 Cortlandt st., New York.

Special tools, models, fine light mach'y and foundry work wanted. Murray Mfg. Co., Richmond Valley, Staten Island, N. Y.

For Sale—Six small automatic friction tapping machines and countershafts, new; capacity ¼ in.; quick reverse. Crescent Tool Works, 1566 Park ave., Bridgeport, Conn.

Wanted—An interest in, or will buy outright, a metal working plant; have option on a profitable specialty that could be combined: East preferred. "Plant," care AMER. MACH.

Mechanical and electrical engineer, with large experience in design and manufacture of supply articles, desires to correspond with party having shop suitable for the manufacture of the same. X. Y. Z., care AM. MACH.

A middle-aged man, with 18 years' experience in the office and selling end of a manufacturing business, wishes to purchase an interest in and associate himself with a small manufacturing business. Box 316, AM. MACH.

Purchaser for small manufacturing plant; lot, 100x180 feet; machine shop, 32x68, two story, with line shaft and gasoline power; foundry, 40x54, new modern equipment; good location; for sale cheap. Hart-Parr Co., Madison, Wis.

Foundry in eastern Pennsylvania, making a specialty of machinery castings, would like to make contract with machinery manufacturing concern for furnishing strictly high-grade castings at lowest figure. Address "Foundry," care AMERICAN MACHINIST.

A thorough machinist, with good shop located in southwestern Ohio, would like to correspond with the object of making permanent contract to build medium weight machinery; those having established trade preferred. Address Box 314, AMERICAN MACHINIST.

Institutions retiring from business having machine tools, brass and wood working machinery will find it to their interest to correspond with us. We purchase complete plants or handle them on com. C. C. Wormer Mach. Co., 55-59 Woodbridge st., W., Detroit, Mich.

The annual meeting of the stockholders of the American Machinist Press, for the election of five directors for the ensuing year and for the transaction of such other business as may properly come before the meeting, will be held at the office of the company, No. 218 William st., in the city of New York, on the 13th day of January, 1902, at 12 o'clock noon.

A. LEIGHTON DONNELL, Secretary.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded; but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents.

Situations Wanted.

Foreman patternmaker wishes a change. Box 12, AMERICAN MACHINIST.

Practical mechanical draftsman wishes position. Box 16, AMERICAN MACHINIST.

Experienced draftsman, 23, desires position with manufacturer of machinery. Box 287, AMERICAN MACHINIST.

Competent draftsman wants position; technical graduate; light complicated machinery preferred. Address Box 302, AMER. MACHI

Draftsman on the European continent seeks position; 3 years in the shop and 5 years at the drawing office; general engineering. Box 13, AMERICAN MACHINIST.

Designer, of inventive ability, a skilled mechanic and registered patent attorney, would like an opening with an appreciative concern. Box 14, AMERICAN MACHINIST.

Position wanted as chief draftsman, assistant superintendent or manager, by competent man, 11 years' experience; machine tools preferred. Box 23, AMERICAN MACHINIST.

Mechanical engineer, experienced in designing fine automatic machinery, wishes position as designer or constructor; competent to take full charge. Box 11, AMER. MACHINIST.

Mechanical engineer and draftsman, practical man, to lay out and superintend erection foundry, steam plants and general work, open for engagement February 1. Box 20, AM. M.

Bookkeeper, experienced factory and up-to-date cost-accountant, wishes position where good, faithful work will be appreciated; goes anywhere; references and bond given. Box 17, AMERICAN MACHINIST.

Position as milling machine foreman; up to date in making jigs, cutters, devices, etc., for rapidly milling interchangeable parts in quantities, also cam and gear cutting; technical, systematic and accurate. Address "Energetic," care AMERICAN MACHINIST.

As assistant to draftsman or toolmaker, by a steady young man; has good education, including electricity, also some experience in mechanical drawing, punch and die work and light brass pattern work; will complete apprenticeship as machinist with Quaker City Mach. Co. Jan. 15, 1902. Address proposition to Wm. H. Singer, Richmond, Ind.

Help Wanted.

Wanted—First-class mechanical draftsman on machine tools. Box 5, AMER. MACHINIST.

Wanted—First-class toolmaker and one machinist. Address Day Mfg. Co., Lake View, N. Y., for 30 days.

A1 planer and lathe hands wanted; only experienced men need apply. Hyatt Roller Bearing Co., Harrison, N. J.

Machinists, first-class men for erecting work; also experienced planer hand. Niagara Machine & Tool Works, Buffalo, N. Y.

Wanted—Mechanical draftsmen; those familiar with coal-handling machinery preferred. Box 9, AMERICAN MACHINIST.

Wanted—In printing press works, draftsman and tracers; state experience and wages required. P. O. Box 604, Plainfield, N. J.

Wanted—Two draftsmen for tool work, by large electrical manufacturing company. Address, with full particulars, Box 21, AM. M.

Wanted—First-class wood pattern makers, machinists and toolmakers, experienced on valves and fittings. Address Box 309, AM. M.

Wanted—By Struthers, Wells & Co., Warren, Pa., a first-class assistant foreman for boiler shop; write at once for particulars, stating experience, etc.

Good patternmakers, both wood and metal, desiring steady employment, will find it to their advantage to apply to the General Electric Co., Schenectady, N. Y.

Wanted—Number of patternmakers, experienced on compressor or steam engine work; none others need apply. Franklin Air-Compressor Co., Franklin, Pa.

Wanted—A first-class mechanical draftsman; one familiar with automatic machinery preferred; state age, experience and salary. Box 300, AMERICAN MACHINIST.

Wanted—In Brooklyn, all-around machinist on machines and vise; must have 6 years' experience; American nationality preferred. Address Box 24, AMERICAN MACHINIST.

Wanted—Draftsman, familiar with machine tools, to work on details; steady employment to right man. Apply, stating age, experience, salary expected, Box 18, AM. M.

Experienced draftsman wanted on mill machinery and machine tools. Permanent employment assured to rapid and accurate draftsman. Bethlehem Steel Company, South Bethlehem, Pa.

Wanted—First-class toolmaker for experimental and jig work, also screw machine hand capable of looking after four No. 2 Pratt & Whitney hand screw machines. Box 10, AMERICAN MACHINIST.

Chief draftsman for large machine works, located in Philadelphia; good, permanent position for right man. Apply, giving full details as to previous work and ability, Box 19, AMERICAN MACHINIST.

Wanted—Experienced mechanical draftsman, familiar with designing heavy machinery; applicants will state previous experience and salary expected; give age and references. Box 7, AMERICAN MACHINIST.

At once, competent mechanical draftsman, thorough and painstaking, for permanent position in drafting room of manufacturing concern in Connecticut, doing variety of work. Address Box 6, AMERICAN MACHINIST.

General machinist, New York city, on high-class work; heavy machinery; a progressive young man of character, experienced, having abilities second to none; especially good opening to such only. Box 15, AMER. MACHINIST.

Wanted—Advertising man, of good address, capable of handling engineering and mechanical advertising in technical papers, preparing catalogs, etc. Address, stating salary expected, experience and reference, L. L. Cline, Detroit, Mich.

We are enlarging our works, and will shortly require an increased number of skilled mechanics; we invite application from pattern makers, molders and machinists. Address the Westinghouse Machine Company, East Pittsburgh, Pa.

Machinists Wanted.—Having enlarged the capacity of our factory, we invite application from first-class machinists capable of doing fine accurate work on high-speed machinery; in applying give references. Vt. Farm Machine Co., Bellows Falls, Vt.

Wanted—Foreman for a small shop manufacturing transmission machinery in the South; a man well up in the manufacture of iron pulleys, hangers, etc., will find a permanent position; give references and state experience. Box 296, AMERICAN MACHINIST.

Wanted—Tool-dresser or blacksmith; must be able to forge and temper high-grade tools, also temper large milling cutters, reamers and forming tools in a first-class manner; must be temperate and industrious; good position for right man. Vt. Farm Machine Co., Bellows Falls, Vt.

Wanted—A first-class patternmaker to work at the bench and have general supervision over the pattern shop; position in a Southern city of 20,000 inhabitants; new modern shop now being erected; a permanent place for the right man; good wages and good treatment guaranteed. Box 8, AMER. MACH.

Wanted—An expert Patent Office draftsman; one who can also make line cuts for illustrating, similar to those in the "American Machinist"; only experienced men in above work need apply. Address, with full particulars as to experience, references and salary expected; young man preferred. Box 4, AMERICAN MACHINIST.

Wanted—A first-class designer who is capable of designing a line of vertical boring mills; salary paid will be compatible with ability, and only a man that is as good as the best in this line of work is desired; the company desiring the services is a first-class machine-tool concern; in replying, fully state your experience and give all information you think would be desirable. Address Box 22, AMERICAN MACHINIST.

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Geometric Drill Co., Westville, Ct.
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Wyman & Gordon, Worcester, Mass.

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Whiting Foundry Equip Co., Harvey, Ill.

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Pratt & Whitney Co., Hartford, Ct.
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Slocomb & Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

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Am. Gas Furnace Co., N. Y. City.

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Bickford Drill & Tool Co., Cin., O.
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Fellows Gear Shaper Co., Springfield, Vt.
Gould & Eberhardt, Newark, N. J.
Newton Mch. Tool Wks., Phil., Pa.
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Cleveland Gear Wks., Cleveland, O.
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New Process Raw Hide Co., Syracuse, N. Y.
N. Y. Gear Works, Brooklyn, N. Y.
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Messmer Mfg. Co., Ferd., St. Louis, Mo.
Turley, H. G., St. Louis, Mo.

Gears, Molded
Farrel Fdry & Mch. Co., Ansonia, Conn.
Greenwald Co., I. & E., Cincin., O.
Poole & Son Co., Robt., Baltimore, Md.

Gears, Rawhide
Boston Gear Wks., Boston, Mass.
Chicago Raw Hide Co., Chicago, Il.
New Process Raw Hide Co., Syracuse, N. Y.

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Dixon Crucible Co., Jos., Jersey City, N. J.

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Safety Emery Wheel Co., Springfield, O.
Whitney Mfg. Co., Hartford, Ct.

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Ransom Mfg. Co., Oshkosh, Wis.
Universal Mach. Co., Provi., R. I.

Grinders, Drill
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Gorton Mach. Co., Geo., Racine, Wis.
Greenfield Mach. Co., Greenfield, Mass.
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Norton Emery Wheel Co., Worcester, Mass.
Ransom Mfg. Co., Oshkosh, Wis.
Universal Mach. Co., Provi., R. I.
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Wilmarth & Morman Co., Grand Rapids, Mich.

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Norton Emery Wheel Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Vitrified Emery Wheel Co., Westfield, Mass.

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Hoefer Mfg. Co., Freeport, Ill.
Millers Falls Co., New York.
West Haven Mfg. Co., New Haven, Conn.

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Niles-Bement-Pond Co., New York.

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Niles-Bement-Pond Co., New York.
Perkins Mach. Co., Boston, Mass.
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Standard Pneumatic Tool Co., Aurora, Ill.

Handles, Machine Tool
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Schacht Mfg. Co., Cincinnati, O.

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Heating and Ventilating Apparatus
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Pawling & Harnischfeger, Milwaukee, Wis.

Hoists, Pneumatic
Curtis & Co. Mfg. Co., St. Louis, Mo.
Northern Engineering Wks., Detroit, Mich.
Rand Drill Co., New York.
Standard Pneumatic Tool Co., Aurora, Ill.

Hoists, Hand
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Yale & Towne Mfg. Co., New York.

Hoisting Machinery
Hunt Co., C. W., West New Brighton, N. Y.

Igniter, Gas Engine
Maxwell Engineering Co., Rome, N. Y.

Injectors
Lunkenheimer Co., Cincinnati, O.
Rue Mfg. Co., Philadelphia, Pa.

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Watson-Stillman Co., New York.

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Davis Mach. Co., W. P., Rochester, N. Y.
Hill Tool Co., Anderson, Ind.
Mitts & Merrill, Saginaw, Mich.

Keys, Machine
Standard Gage Steel Co., Beaver Falls, Pa.
Whitney Mfg. Co., Hartford, Ct.

Lathes, Bench
Faneuil Watch Tool Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Ct.

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Besly & Co., C. H., Chicago, Ill.
Hill Tool Co., Anderson, Ind.
Le Count, Wm. G., So. Norwalk, Conn.

Lathe Feed
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Lathes
American Tool Wks. Co., Cin., O.
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Baird Machy. Co., U., Pittsburgh, Pa.
Barker & Chard Mach. T. Co., Cincinnati, O.
Barnes Co., B. F., Rockford, Ill.
Barnes, W. F. & John, Rockford, Ill.
Blaisdell & Co., P., Worcester, Mass.
Bradford Mach. Tool Co., Cin., O.
Bullard Mach. Tool Co., Bridgeport, Conn.
Davis Mach. Co., W. P., Rochester, N. Y.
Diamond Mach. Co., Provi., R. I.
Fairbanks Mach. Tool Co., Springfield, O.
Flather Planer Co., Mark, Nashua, N. H.
Grant Tool Co., Franklin, Pa.
Greaves, Klusman & Co., Cin., O.
Harrington, Son & Co., Edwin., Philadelphia, Pa.
Hendey Mach. Co., Torrington, Ct.
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Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
McCabe, J. J., New York.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Reed Co., F. E., Worcester, Mass.
Schumacher & Boye, Cincinnati, O.
Sebastian Lathe Co., Cincin., O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Shepard Lathe Co., Cincinnati, O.

Levels
Smith, E. G., Columbia, Pa.

Link Belts
Jeffries Mfg. Co., Columbus, O.
Link Belt Engineering Co., Philaphia, Pa.

Lockers, Clothes
Merritt & Co., Philadelphia, Pa.

Locomotives, Shop
Hunt Co., C. W., West New Brighton, N. Y.

Lubricants
Dixon Crucible Co., Jos., Jersey City, N. J.

Lubricators
Bowen Mfg. Co., Auburn, N. Y.
Lunkenheimer Co., Cincinnati, O.

Machinery Builders, Special
Am. Ordnance Co., Bridgeport, Ct.
Diamond Mach. Co., Provi., R. I.
Hardinge Bros., Chicago, Ill.
Lucas Mach. T. Co., Cleveland, O.

Machine Screws
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Machinists' Small Tools
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Hammacher, Schlemmer & Co., New York.
Mass. Tool Co., Greenfield, Mass.
Pratt & Whitney Co., Hartford, Ct.
Reichhelm & Co., E. P., New York.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Starrett Co., L. S., Athol, Mass.

Magnetic Separator
Sawyer, Ezra, Worcester, Mass.

Mandrels, Solid
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Rogers, John M., Boat, Gage & Drill Works, Gloucester City, N. J.
Wells Bros. Co., Greenfield, Mass.

Measuring Machines
Pratt & Whitney Co., Hartford, Ct.
Rogers, John M., Boat, Gage & Drill Works, Gloucester City, N. J.

Micrometer Calipers
Brown & Sharpe Mfg. Co., Providence, R. I.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb & Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.
Syracuse Twist Drill Co., Syracuse, N. Y.

Milling Attachments
The Adams Co., Dubuque, Iowa.
Cincinnati Milling Mach. Co., Cincinnati, O.
Kempsmith Mfg. Co., Milwaukee, Wis.

Milling Machines, Bench
Faneuil Watch Tool Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Ct.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Plain
American Tool Wks. Co., Cin., O.
Aurora Tool Works, Aurora, Ind.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mach. Co., Cincinnati, O.
Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Kempsmith Mfg. Co., Milwaukee, Wis.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Whitney Mfg. Co., Hartford, Ct.

Milling Machines, Portable
Underwood & Co., H. B., Philadelphia, Pa.

Milling Machines, Universal
Amer. Tool Wks. Co., Cincin., O.
Aurora Tool Works, Aurora, Ind.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mach. Co., Cincinnati, O.
Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Kempsmith Mfg. Co., Milwaukee, Wis.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Ct.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Heavy Horizontal
The Adams Co., Dubuque, Iowa.
Beaman & Smith Co., Provi., R. I.
Franklin Mach. Wks., Phila., Pa.
Grant Tool Wks., Franklin, Pa.
Hendey Mach. Co., Torrington, Ct.
Ingersoll Mill. Mach. Co., Rockford, Ill.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.

Milling Machines, Vertical
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Newton Mach. Tool Wks., Philadelphia, Pa.

Molding Machines
The Adams Co., Dubuque, Iowa.
Webster & Perks Tool Co., Springfield, O.

Motors, Electric
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Eddy Electric Mfg. Co., Windsor, Conn.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Robbins & Myers Co., Springfield, Ohio.
Sprague Electric Co., New York.
Triumph Elec. Co., Cincinnati, O.
Western Electric Co., Chicago, Ill.

Nut Tappers
See Bolt and Nut Machinery.

Oilers
Bay State Stamping Co., Worcester, Mass.

Oilless Bearings
Arguto Oilless Bearing Co., Philadelphia, Pa.

Oil Can Fillers
The Winkley Co., Hartford, Conn.

Oil Cups and Covers
Besly & Co., C. H., Chicago, Ill.
Bowen Mfg. Co., Auburn, N. Y.
Crane Co., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
The Winkley Co., Hartford, Conn.

Packing, Steam Joint
Jenkins Bros., New York.

Paints, Machinery
Detroit White Lead Works, Detroit, Mich.

Patterns, Wood
Gobeille Pattern Co., Cleveland, O.
Olmstead Co., H. B., New York.

Patent Solicitors
Baldwin, Davidson & Wight, Washington, D. C.
Bevans, James W., Washington, D. C.
Copp & Co., Washington, D. C.
Cromwell, W. H., Washington, D. C.

Pattern Letters
Butler, A. G., N. Y. City.

Pattern Shop Machinery
American Machinery Co., Grand Rapids, Mich.
Greaves, Klusman & Co., Cincinnati, O.

Phosphor Bronze
Phosphor Bronze Smelting Co., Philadelphia, Pa.

Pipe Cutting and Threading Machines
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Curtis & Curtis Co., Bridgeport, Conn.
Merrell Mfg. Co., Toledo, O.
Saunders' Sons, D., Yonkers, N. Y.
Wells Bros. Co., Greenfield, Mass.

Pipe Fitters' Tools
Saunders' Sons, D., Yonkers, N. Y.
Standard Tool Co., Cleveland, O.

Pipe and Fittings
Crane Co., Chicago, Ill.

Planer Jacks
Armstrong Bros. Tool Co., Chicago, Ill.

Planers, Metal
Amer. Tool Wks. Co., Cincin., O.
Bartlett, E. E., Boston, Mass.
Belmer-Eames Tool Co., Cin., O.
Betts Mach. Co., Wilmington, Del.
Cincinnati Planer Co., Cincin., O.
Cleveland Punch & Shear Wks. Co., Cleveland, O.
Detrick & Harvey Mch. Co., Baltimore, Md.
Flather Planer Co., Mark, Nashua, N. H.
Gray Co., G. A., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Niles-Bement-Pond Co., New York.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Wks., Philadelphia, Pa.
Pond Mach. Co., L. W., Worcester, Mass.
Pratt & Whitney Co., Hartford, Ct.
Sellers & Co., Wm., Phila., Pa.
Whitcomb Mfg. Co., Worcester, Mass.
Woodward & Powell Planer Co., Worcester, Mass.

Planers, Portable
Morton Mfg. Co., Muskegon Heights, Mich.
Underwood & Co., H. B., Philadelphia, Pa.

Presses, Hand
Elmes Engineering Wks., Chas. F., Chicago, Ill.
Pratt & Whitney Co., Hartford, Conn.

Presses, Hydraulic
Elmes Engineering Wks., Chas. F., Chicago, Ill.
Watson-Stillman Co., New York.

Presses, Power
Bliss Co., E. W., Brooklyn, N. Y.
Perkins Mach. Co., Boston, Mass.

Profilers
Garvin Mach. Co., New York.
Pratt & Whitney Co., Hartford, Ct.

Pulleys
Poole & Son Co., Robt., Baltimore, Md.
Reeves Pulley Co., Columbus, Ind.

Pulley Covering
Warren Co., Chicago, Ill.

Pulleys, Friction Cone
Evans Friction Cone Co., Boston, Mass.

Pulleys, Speed Changing
Speed Changing Pulley Co., Indianapolis, Ind.

Pulley Turning and Boring Machines
Harrington, Son & Co., Edwin, Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.

Pumps, Hydraulic
Watson-Stillman Co., New York.

Punches, Hydraulic
Watson-Stillman Co., New York.

Punches, Power
Cleveland Punch & Shear Wks., Cleveland, O.
Hilles & Jones Co., Wilmington, Del.
Long & Allstatter Co., Hamilton, Ohio.
Perkins Mach. Co., Boston, Mass.

Racks, Cut
Standard Gage Steel Co., Beaver Falls, Pa.

Racks, Tool
New Britain Mach. Co., New Britain, Conn.

Rack Cutting Machines
Fellows Gear Shaper Co., Springfield, Vt.
Reed Co., F. E., Worcester, Mass.

Ratchet Drills
Curtis & Curtis Co., Bridgeport, Conn.
Parker Co., Chas., Meriden, Ct.

Reamers
Chadwick & Co., G. B., Portsmouth, N. H.
Cleveland Twist Drill Co., Cleveland, O.
Clough, R. M., Tolland, Ct.
Geometric Drill Co., Westville, Ct.
McCrosky & Huber, Cincinnati, O.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Rogers, John M., Boat, Gage & Drill Wks., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Wells Bros. & Co., Greenfield, Mass.

Recording Gages
Bristol Co., Bridgeport, Conn.

Recorders, Speed
Starrett Co., L. S., Athol, Mass.

Riveters, Hydraulic
Watson-Stillman Co., New York.

Riveting Machines
Bethlehem Foundry & Mach. Co., So. Bethlehem, Pa.
Chambersburg Engineering Co., Chambersburg, Pa.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Riveters, Pneumatic
Standard Pneumatic Tool Co., Aurora, Ill.

Roller and Ball Bearings
Ball Bearing Co., Boston, Mass.
Roller Bearing & Equip. Co., Keene, N. H.

Rolling Mill Machinery
Cleveland Punch & Shear Wks. Co., Cleveland, O.
Diamond Drill & Mach. Co., Birdsboro, Pa.

Rotary Planers
Franklin Mach. Wks., Phila., Pa.
Underwood & Co., H. B., Phila., Pa.

Safety Valves, Pop
Crane Co., Chicago, Ill.
Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

Sand Blast Apparatus
Paxson Co., J. W., Phila., Pa.

Sand Mixing Machines
Sellers & Co., Wm., Phila., Pa.
Smith Foundry Supply Co., J. D., Cleveland, O.

Schools, Correspondence
Amer. School of Correspondence, Boston, Mass.
Consolidated Schools, N. Y. City.
International Correspon. Schools, Scranton, Pa.

Schools, Technical
Ohio State University, Columbus, Ohio.

Screw Plates
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Card Mfg. Co., S. W., Mansfield, Mass.
Hart Mfg. Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Screws, Wood and Lag
Baker Bros., Toledo, Ohio.

Second Hand Machinery
Bowler & Co., Geo. H., Cleveland, Ohio.
Dawson, John H., Chicago, Ill.
Doan & Co., J. B., Chicago, Ill.
Fairbanks Co., Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mchy. Co., Chicago, Ill.
McCabe, J. J., New York.
Pitkin Machy. Co., J. B., Providence, R. I.
Prentiss Tool & Supply Co., New York.
Toomey, Frank, Philadelphia, Pa.
Wormer Machy. Co., C. C., Detroit, Mich.

Shaft Couplings
Davis Mach. Co., W. P., Rochester, N. Y.
Stuart, R. J., New Hamburg, N. Y.

Shapers
Amer. Tool Wks., Co., Cincin., O.
Cincinnati Shaper Co., Cincin., O.
Flather Planer Co., Mark, Nashua, N. H.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., Boston, Mass.
Kelly Co., R. A., Xenia, Ohio.
Morton Mfg. Co., Muskegon Heights, Mich.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Perkins Mach. Co., Boston, Mass.
Potter & Johnston Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Ct.
Steptoe & Co., John, Cincinnati, O.

Shapers, Vertical Die
Rochester Die Shaper Co., Rochester, N. Y.

Shears, Power
Bliss Co., E. W., Brooklyn, N. Y.
Cleveland Punch & Shear Wks., Cleveland, O.
Hilles & Jones Co., Wilmington, Del.
Long & Allstatter Co., Hamilton, Ohio.
Perkins Mach. Co., Boston, Mass.

Shears, Rotary
Bethlehem Foundry & Mach. Co., So. Bethlehem, Pa.
Bliss Co., E. W., Brooklyn, N. Y.

Shop Shelving and Tool Holders
New Britain Mach. Co., New Britain, Conn.

Slide Rest
Bartlett, E. E., Boston, Mass.

Slotters
Baker Bros., Toledo, Ohio.
Betts Mach. Co., Wilmington, Del.
Franklin Mach. Wks., Phila., Pa.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.

Springs
Cleveland Wire Spring Co., Cleveland, O.
Dunbar Bros., Bristol, Conn.

Sprocket Chains
See Driving Chains.

Stamps, Letters and Figures
Schwerdtle Stamp Co., Bridgeport, Conn.

Steam Columns, Traps, Etc.
Wright Mfg. Co., Detroit, Mich.

Steam Exhaust Heads
Austin Separator Co., Detroit, Mich.

Steam Fittings
Crane Co., Chicago, Ill.
Crosby Steam Gage & Valve Co., Boston, Mass.
Jenkins Bros., New York.
Lunkenheimer Co., Cincinnati, O.
Walworth Mfg. Co., Boston, Mass.
Wright Mfg. Co., Detroit, Mich.

Steam Engine Indicators
Crosby Steam Gage & Valve Co., Boston, Mass.

Steam Gages
Crosby Steam Gage & Valve Co., Boston, Mass.

Steam Separators
Austin Separator Co., Detroit, Mich.

Stampings, Sheet Metal
Automobile & Cycle Parts Co., Cleveland, O.
Bliss Co., E. W., Brooklyn, N. Y.

Steel, Sheet
Automobile & Cycle Parts Co., Cleveland, O.

Steel, Machinery
Ward & Son, Edgar T., Boston, Mass.

Straightener, Hydraulic
Watson-Stillman Co., N. Y. City.

Straightener, Screw
Towsley Mfg. Co., J. T., Cincin., O.

Swaging Machines
Excelsior Needle Co., Torrington, Conn.

Switchboards
C & C Electric Co., New York.
Triumph Elec. Co., Cincinnati, O.

Tapping Machines and Attachments
Baker Bros., Toledo, O.
The Beaman & Smith Co., Providence, R. I.
Bickford Drill & Tool Co., Cin., O.
Errington, F. A., N. Y. City.
Fosdick & Holloway Mach. Tool Co., Cincinnati, O.
Fulton Fdry. & Mach. Co., Brooklyn, N. Y.
Garvin Mach. Co., New York.
Geometric Drill Co., Westville, Ct.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Union Tire Co., Plainfield, N. J.
Webster & Perks Tool Co., Springfield, O.

Taps and Dies
Besly & Co., Chas. H., Chicago, Ill.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Crane Co., Chicago, Ill.
Hart Mfg. Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Wells Bros. & Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Threading Dies, Opening
Errington, F. A., New York.
Geometric Drill Co., Westville, Ct.
Jones & Lamson Mch. Co., Springfield, Vt.
Modern Tool Co., Erie, Pa.

Thread Cutting Tools
Rivett-Dock Co., Boston, Mass.

Tool Grinders
Gisholt Mach. Co., Madison, Wis.
Leland & Faulconer Mfg. Co., Detroit, Mich.

Tool Holders
Armstrong Bros. Tool Co., Chicago, Ill.
Hill Tool Co., Anderson, Ind.
McCrosky & Huber, Cincinnati, O.

Tools
See Machinists' Small Tools.

Transmission Machinery
Caldwell & Son Co., H. W., Chicago, Ill.
Link-Belt Engineering Co., Philadelphia, Pa.
Reeves Pulley Co., Columbus, Ind.

Trolleys and Tramways
Brown Hoisting Machy. Co., N. Y. City.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hunt Co., C. W., West New Brighton, N. Y.
Link Belt Engineering Co., Philadelphia, Pa.
Maris Bros., Philadelphia, Pa.
Pawling & Harnischfeger, Milwaukee, Wis.
Yale & Towne Mfg. Co., New York.

Trucks, Shop
Towsley Mfg. Co., J. T., Cin., O.

Tumbling Barrels
Byram & Co., Inc., Detroit, Mich.

Turret Machines, Automatic
Automatic Mach. Co., Bridgeport, Conn.
Barker & Chard M. T. Co., Cin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Mach. Tool Co., Bridgeport, Conn.
Cleveland Mach. Screw Co., Cleveland, O.
Dreses, Mueller & Co., Cincin., O.
Garvin Mach. Co., New York.
Gisholt Mch. Co., Madison, Wis.
Grant Tool Co., Franklin, Pa.
Hill, Clarke & Co., Boston, Mass.
Jones & Lamson Mch. Co., Springfield, Vt.
Lodge & Shipley Mach Tool Co., Cincinnati, O.
Pearson Mach. Co., Chicago, Ill.
Potter & Johnston Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Ct.
Warner & Swasey Co., Cleveland, Ohio.
Windsor Mach. Co., Windsor, Vt.

Twist Drills
Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & M. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.

Universal Joints
Baush Machine Tool Co., Springfield, Mass.
Vanderbeek Tool Wks., Hartford, Conn.

Valves
See Steam Fittings.

Vises, Wood Workers'
Wyman & Gordon, Worcester, Mass.

Vises, Metal Workers'
Hollands Mfg. Co., Erie, Pa.
Merrill Bros., Brooklyn, N. Y.
Parker Co., Chas., Meriden, Conn.
Walworth Mfg. Co., Boston, Mass.

Vises, Pipe
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Saunders' Sons, D., Yonkers, N. Y.
Walworth Mfg. Co., Boston, Mass.

Vises, Planer and Shaper
Cincinnati Planer Co., Cincin., O.
Hendey Mach. Co., Torrington, Ct.

Welding Machines
Long & Allstatter Co., Hamilton, Ohio.

Wood and Lag Screw Machinery
Baker Bros., Toledo, Ohio.
Cook Co., Asa S., Hartford, Conn.

Wood Trimmers
Amer. Mchry Co., Grand Rapids, Mich.
Leland & Faulconer Mfg. Co., Detroit, Mich.

Wrenches, Drop Forged
Williams & Co., J. H., Brooklyn, N. Y.

Worm Hobbing Machines
Grant Tool Wks., Franklin, Pa.

Worm Gearing
Albro-Clem Elevator Co., Philadelphia, Pa.
Fawcus Mach. Co., Pittsburgh, Pa.
Morse, Williams & Co., Phila., Pa.
Nuttall Co., R. D., Pittsburgh, Pa.

Worm Milling Machines
Cleveland Mach. Screw Co., Cleveland, O.

The Premium Plan at the Works of David Rowan and Company, Glasgow, Scotland.

BY JAMES ROWAN.

It might be well to relate how it came about that we introduced the premium system into our works. We make nothing but marine engines, in which there is a great variety of work involving articles weighing from less than a pound up to those weighing many tons. Previous to the strike which ended in the end of January, 1898, it had always been looked upon as impossible to introduce piece work into a marine-engine factory on account of the great variety of work. During the strike we determined to introduce a premium system of some description, and it was while investigating the subject that I struck upon the system which we adopted. We commenced with one machine and added others, until in about four months' time we had every machine—numbering about eighty—in our engine department on the premium system. We then introduced it into the erecting department and to the fitting of the engines on board the ship at the crane, and now all our smiths who used to work on the time and piece-work systems are on the premium. Our men in the machine department are earning about time and a third. Although we are paying this high rate of wages we believe our wages cost would compare favorably with any other marine-engine factory. Of course, we cannot tell how our wages cost compares with other places, as we do not know and have no means of ascertaining what the wages cost of other firms is. At the same time we know we are getting a great deal more work out of the machines under the premium system than we ever did before. It has involved an entire remodeling of our place. We have now no old machines, and now no equipment but the very best and the most modern satisfies us.

Mr. Thomson—my partner—spent three months in America in the summer of 1898. We have all visited the principal works in this country and have all been to Germany, principally to see Messrs. Loewe's works. When I say all, I mean Mr. Thomson, our engine and boiler works managers and perhaps six or eight of our principal foremen and myself.

My system was described in my paper before the Glasgow Engineering Congress thus:

"Work as recorded on a job ticket is given to a workman on a time allowance, and if he reduces this time allowance his rate of wages per hour while he is working at the job is increased by the same percentage as that by which the time allowance has been reduced. It is of course apparent that data must be collected for the purpose of arriving at the time to be allowed to do work. For this purpose a special department (rate-fixing department) is required, and when instituted, data accumulate very quickly. The period occupied

Wages, Rate $.30 per hour.

Hours Allowed.	Hours taken.	Time wages on Job.	Premium earned on Job.	Total cost.	Workman's rate per hour.
100	100	$30.00	$ .00	$30.00	$ .30
100	90	27.00	1.00	28.00	.311
100	80	24.00	2.00	26.00	.325
100	70	21.00	3.00	24.00	.343
100	60	18.00	4.00	22.00	.366
100	50	15.00	5.00	20.00	.40
100	40	12.00	6.00	18.00	.45
100	30	9.00	7.00	16.00	.533
100	20	6.00	8.00	14.00	.70
100	10	3.00	9.00	12.00	1.20
100	1	.30	9.90	10.20	10.20

HALSEY'S METHOD

Wages, Rate $.30 per hour.

100	100	$30.00	$ .00	$30.00	$ .30
100	90	27.00	1.50	28.50	.316
100	80	24.00	3.00	27.00	.337
100	70	21.00	4.50	25.50	.364
100	60	18.00	6.00	24.00	.40
100	50	15.00	7.50	22.50	.45
100	40	12.00	9.00	21.00	.525
100	30	9.00	10.50	19.50	.65
100	20	6.00	12.00	18.00	.90
100	10	3.00	13.50	16.50	1.65
100	1	.30	14.85	15.15	15.15

WEIR'S METHOD

Wages, Rate $.30 per hour.

100	100	$30.00	$ .00	$30.00	$ .30
100	90	27.00	2.70	29.70	.33
100	80	24.00	4.80	28.80	.36
100	70	21.00	6.30	27.30	.39
100	60	18.00	7.20	25.20	.42
100	50	15.00	7.50	22.50	.45
100	40	12.00	7.20	19.20	.48
100	30	9.00	6.30	15.30	.51
100	20	6.00	4.80	10.80	.54
100	10	3.00	2.70	5.70	.57
100	1	.30	.297	.597	.597

ROWAN'S METHOD

American Machinist

TABLE 1. COMPARISON OF DIFFERENT METHODS OF CALCULATING PREMIUMS.

											12/11/01		No.	950	
	5	10½	3	6¾	X	193	34	1	10¼	24½					
	6	99	35	43½	51	204	70½	18	24½	35					
	8	18	24	7¾	X	21	337½	18	51	161					
	19	32	2	4¼	22	34					180				
8¼	20	16½	6	5¼	9	56	51	3	17¼	33	208	40	2	29¾	X
	23	111	3	36¾	49	63	5	1	¾	X	209	45	6	6¾	19½
	24	50	4	1⅛	30	69	18	6	11¾	X	212				
	25	112	8	14¼	55	82	36	4	9¼	27					
	30	20	10	14¾	X	117					160	18	3	1½	7
	31	30	11	25½	X	142	40	50	15¾	X	171	51	11	21½	35
	36	40	8	12	20	153	39	3	14½	17	191	50	4	20¼	25
21¼	37	48	12	18¾	33	165-6	16½	6	4¾	8¼	222	22	6	13	16
	44	128¼	57	34½	76	35 183	60	1	35	36	224	41	1	23½	28
	46					184	210	12	57	105	231	35	1	17¼	20½
	61	36	1	16	18	206	14½	1	7¼	7¼	10	49½	6	40¾	36
	71	17½	35	14½	X	211					66	108	6	28¾	54
	75	170	18	43¼	102	225	15	1	2⅛	8	101				
	167	77	47	61¼	55	9	18	12	16½	13	214	84	6	55½	56
	168	40	8	5	X	13	19½	2	11	X	215	12	8	6	X
	170	102	6	44¼	52	30 18	48	3	27½	33	134				
	192	40	1	2¼	20	32	15	28	8¼	X	161	26	1	12½	13
	210	114	6	57⅛	65½	33	11	9	2¾	X	182	12	6	4¼	9
						62	13	12	7¼	X	194	60	3	28¾	30
	22	13	1	8¼	9	65	11	42	1	X	64				
	26	44	12	19¼	33	109					68				
	27	42	24	6¼	X	110					201	30	127	8¾	X
	70	12	8	6	X	112					216				
	164	51	6	14	25½	114					217				
	169	48	6	9	36	163	8	14	4½	X	239	58	138	21¾	29

American Machinist

TABLE 2. JOB PROGRESS CARD.

JOB REGISTER.

(MACHINE DEPT.)

MAIN ENGINES:—*PISTON AND CONNECTING RODS.*

Connecting Rods.

316. 1st Operation.—Turning complete.

317. 2nd Operation, Type "A".—Slotting outside flats of forks and sides of bottom butts.

318. 2nd Operation, Type "B".—Slotting sides of bottom butts.

319. 3rd Operation, Type "A".—Slotting round gudgeon.

320. 3rd Operation, Type "B".—Slotting flats of forked end.

321. Sawing out jaw.

322. Finishing jaw after sawing.

323. Boring out jaw and finishing.

324. 5th Operation, Type "A".—Slotting inside of jaw.

325. 5th Operation, Type "B".—Slotting inside of jaw and sides of top butts.

326. Boring out and finishing for gudgeon.

327. Boring out crosshead and crank pin bolt holes.

328. Boring oil holes in each connecting rod.

TABLE 3.

in doing work under the usual time payment conditions may be accepted as the time allowance of the premium system.

"When a job is given to a workman, a job ticket is issued to him with a description of the work to be done and the time allowed to do it. On completion of the work the job ticket is initialed, and the time of day recorded on it by the foreman, and this is the time of commencing the next job. When the work has been examined and passed by the works inspector, the job ticket is handed to the rate-fixing department, which passes the same for payment. In the case of a job being rejected by the inspector, any premium which would otherwise have been earned by the workman, by reason of his having reduced the time allowance, is forfeited. No clerical labor devolves upon the workmen, and very little upon the foremen.

"The time allowance for a job given to a workman rated at, say, 8d. per hour is 100 hours, and the actual time occupied on the job amounts to 75 hours. We have then 100 hours at 8d. = 800 pence against 75 hours at 8d. + 25 per cent. (2d.) = 750 pence, giving the workman a premium = 150 pence or 2d. per hour, and the employer a reduced cost = 50 pence. Provided the time allowances are equitable to employer and employed, and based on the average attainments of hourly labor, it will be evident from the foregoing that the higher the premium earned by the workman the greater will be the saving in cost. The output of the machines is also increased, but it is a hard matter to put a value to this."

The enclosed Table I shows your method of premium system, that adopted by Messrs. G. & J. Weir, of this city, and our system. Messrs. Weir's is exactly the same as yours in principle, with the exception that the workman receives half the time saved and in your case he receives one-third.* My system is totally different. You will notice in the last line of the table showing the results of your system that a workman, if he is allowed 100 hours to do a piece of work and does it in one hour he receives about 34 times his hourly rate of wages; with Weir's system he receives 50 times; with our system not quite double. Also compare the next to the last line, showing with your system his wages are increased 4 times, with Weir's 5½ times, with mine 90 per cent., or 10 per cent. less than double.

In quoting the last two lines of the table showing the results of your system, Weir's system and my system, you will no doubt remark that these are extreme cases and seldom to be met with, but these are the cases we are aiming at and hope to arrive at some day, although it may be a long way off. When we do arrive at them we will not require to cut the man's rate, but you will and so will the Messrs. Weir, so that while yours is a decided improvement upon the ordinary piece-work system at the earlier stages, there is no great improvement upon the ordinary piece-work system when you come to great reductions in the hours taken, and these are the stages at which you wish to encourage the men as well as at the earlier stages, and that is where I think my system has the great advantage of any system which I have yet heard of.

We are still improving upon our results and hope to continue doing so. If we were to continue oing so, you will observe that with your system and Messrs. Weir's, in the course of time, we would require to cut the rates, while with my system we would not. We would rather encourage the men to do better and better. The view I take is that no matter how good a machine is, no matter how good work we are getting out of it, that is no reason why we should not get better work out of that machine or why the machine should not be greatly improved to do better work or that the job should not be done in another way. There is no getting over the fact that if ever you have to cut rates it tells very much against the premium system. We have never yet cut a rate unless we have made a radical change in the method of doing the work. We have made changes in cases like the following:

When a horizontal boring machine with one spindle has been replaced by a machine with two spindles. We have in that case reduced the time allowance, but we have reduced it in such a measure that the man was enabled to make rather more with two spindles than he did with the one spindle.

You have asked me to give you tabular information showing time, wages and cost before and after the adoption of the system, and you say this is worth more than all the rest. On the other hand, we look upon this as of little value, although it may arouse interest in the premium system. We attach more importance to the latest records than to anything else. Since we

*Mr. Rowan is of course in error in assuming my idea to be thus limited. The amount of the premium rate has received as much or more discussion in these columns than any other feature of the system.—F. A. H.

Job Register Number 389 Turning Complete — Part of Engine Crank Shaft — Operation Turning & furnishing complete

	Eng. No.	No. of Pieces	Date In	Date Out	Time Allowed	Time Taken	Details of Operation	Remarks	Class Mark	Operator	Machine No.
			1900								
Jobbing	398	1	23/3	27/3	40	23¾		Job 389	II	D Stewart	193
	330	1	5/4	10/4	50	25¼		" 389	II	Gillan	193
	331	1	31/3	5/4	50	35¼		" 389	II	Stewart	193
Jobbing	387	1	10/4	13/4	46	25		" 389	II	Gillan	193
Jobbing	402	1	4/4	5/4	30	11¾	Roughing body	Solid crank	III	T. Ayton	170
	330	1	19/4	21/4	50	29½		Job 389	II	Gillan	193
	330	1	13/4	19/4	50	25		" 389 L.P.	III	Gillan	193
	332	1	5/6	8/6	50	32¾		" 389	II	Gillan	193
	332	1	8/6	12/6	50	29¾		" 389	II	Gillan	193
	332	1	13/6	15/6	50	27½		" 389	II	Gillan	193
	333	1	12/6	18/6	50	24¾		" 389	III	Gillan	193
	1 Spare										
	335	2	16/5	23/5	92	46		" 389 Steel	II	Gillan	193
Jobbing	402	1	20/6	23/6	60	39		" 389	II	Gillan	193
	333	1	23/6	26/6	50	25		" 389	II	Gillan	193
Jobbing	467	1	26/7	27/7	35	21¾		" 389	II	Stewart	3
Jobbing	467	3	7/7	10/7	23	22	Rough turning & finishing for web	2 Centre and 1 forward pieces	=	Craney (App.)	36
	336	1	4/8	7/8	33	15¼		Job 389	II	Gillan	193
	337	1	10/8	13/8	33	15		" 389	III	do.	193
	337	1	13/8	15/8	33	15¾		" 389	II	do.	193
	336	1	8/8	10/8	33	15¼		" 389	II	do.	193
	336	1	7/8	8/8	33	15¼		" 389	II	do.	193
	337	1	10/8	10/8	33	15¾		" 389	II	do.	193
	333	1	2/8	4/8	50	27		" 389	II	do.	193
				etc.			etc.		etc.		

2nd Operation Type A — 2nd Operation Type B — 3rd Operation — 5th Operation (A) — 5th Operation (B)

Part of Engine Connecting Rods — Operation Slotting

Eng. No.	No. of Pieces	Date In	Date Out	Time Allowed	Time Taken	Details of Operation	Remarks	Class Mark	Operator	Machine No.
		1900								
330	3	8/2	3/3	90	63	2nd. and 3rd. operation	Job 318, 320	II	Ritchie	160
330/1/2	9	3/3	15/3	135	87	5th. operation	" 325	III	do.	160
1 Sp.										
335	4	12/4	14/4	20	17½	2nd. operation	" 317	I	do.	160
333	3	2/4	11/4	90	69¼	2nd. and 3rd. operation	" 318, 320	II	do.	160
334	3	14/4	19/4	30	23¾	2nd. operation	" 317	II	do.	160
334	3	19/4	25/4	64½	48¾	3rd. operation	" 319	II	do.	160
333	3	3/5	7/5	45	29	5th operation	" 325	III	do.	160
334	3	28/4	3/5	48	36	5th. operation	" 324	II	do.	160
1 Sp.										
335	4	5/5	14/5	64	47	3rd. operation	" 319	II	Airlie	47
336	2	17/5	23/5	48	26¾	2nd. and 3rd. operation	" 318, 320	II	Ritchie	160
1 Sp.										
335	4	1/6	4/6	24	16	5th. operation	" 324	II	Airlie	47
1 Sp.										
335	4	30/5	1/6	20	14	Sawing out jaw	" 321	II	Fraser	194
336	1	9/8	15/8	24	16	2nd. and 3rd. operation	" 318, 320	II	Ritchie	160
337	3	16/8	24/8	72	47¼	2nd. and 3rd. operation	" 318, 320	II	do.	160
336	3	15/8	25/8	21	16¼	5th. operation	" 325	II	do.	160
321/31	2	30/8	4/9	20	18¾	2nd. operation	" 317	I	do.	160
337	3	8/9	12/9	21	19¾	5th. operation	" 325	I	do.	160
321&31	2	4/9	7/9	43	35½	3rd. operation	" 319	II	do.	160
321&31	2	19/9	21/9	20	17½	Sawing out jaw	" 321	I	Fraser	194
335	2	7/7	9/7	13	14¾	" " "	" 321	III	do.	194
337	3	27/8	29/8	30	27¾	" " "	" 321	II	do.	194
321&31	2	30/9	21/9	16	14¾	Finishing jaw already sawn out.	" 322	—	Ritchie	160
W.R.O.										
332	2	10/10	11/10	20	17¾	2nd. operation	" 317	I	Airlie	47
		etc.			etc.		etc.			

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TABLE 4. PAGES FROM JOB DATA BOOK.

introduced the premium system, almost every machine in our place has been renewed or greatly improved, so that although we could give these data they would be of little value, as the conditions are not the same. I would specially draw your attention to the Job Progress Card which is shown as Table 2. It was described in my paper before the Engineering Congress thus:

"This card is prepared every morning by the rate-fixing department, and indicates the progress which has been made at the various machines; and it may be made of great value to employers and managers. The first column gives the machine numbers, the second column the hours allowed for the jobs in hand, the third column the number of pieces included in each job, the fourth column the hours spent upon the job in hand till 10.30 A. M. on the date the card is prepared, and the fifth column the previous records for similar jobs. The card is therefore an index of the progress of work in each and all machines in operation."

We have three of these prepared every morning—one for myself, one for my partner, and one for our engine works manager—and we find them to be of great value in giving us an intelligent interest of the work being done in the various machines. The cards are written in pencil, and when a record is created it is written in ink, giving the last record and the record now created; when the time allowed is exceeded, it is written in red ink, but this seldom occurs. If we should happen to be away from the works for a few days, on our return we go over these cards and are made acquainted with what is being done in a very thorough manner.

In my paper before the Engineering Congress I said:

"There is a Job Register Book [of which a sample page is given in Table 3.—Ed.] for the machine, brass-finishing, tinsmiths' and smiths' departments, erecting in the works and fitting on board the machinery in the yard and at the quay. As new jobs occur, they are duly registered. Every

Job Register Number
9. Shrinking liners on propeller shaft.
10. Cutting keyseat in shaft and fitting key.
11. Tapping holes and pinning liners on shaft. Fitting nuts and stoppers to shaft.
12. Bolting together steel couplings with black bolts.

Part of Engine. Propeller Shaft.
Operation. Fitting.

Eng. No.	Date Finished	Hours Allowed	Hours taken						Prem Time	%	Workman's Nos.	Job Line No.	Job No.	Class Mark	Remarks
			Jour.	S.App.	J.App.	Boys	Labs.	Total							
325 Spare	7/5/00	5	4					4	4	20	381	287/15	11	III	
325 "	7/5/00	3½	2¾					2¾	2¾	35	381	287/23			Fitting in key and cutting off centre.
331	8/5/00	55	38¾	15¾				54	50	8	371/81 303/87	287/24	10.11	I	
331	9/5/00	4½	2	2				4	3½	22	381,571	287/66		III	Tapping 1-¾ hole thro. nut.
345	19/6/00	20	25	2				27	20¾		381,567	290/46	10	III	
Jobbing 387	24/5/00	55	19¾	19¾				39½	34¾	35	381,571	286/59	10.11	III	
331 Spare	25/5/00	4½	2½					2½	2½	44	381			III	Tapping 1-¾ hole thro. nut.
331 "	25/5/00	55	14	16½				30½	26½	51	381,571	286/82	10.11	III	
1	8/6/00	116	92½					92½	92½	20	265	500/21	10.	II	
330	2/7/00	55	37¾					37¾	37¾	31	381	307/49	10.11	II	
342 Spare	7/7/00	3¾	3¾					3¾	3¾		388	309/83		III	Trying shaft into boss
342 "	3/8/00	50½	16¾		16¾			32¾	24¾	59	381,619	310/46	10.11	III	and marking off and
321 "	31/7/00	55	18		18			36	27	50	381,619	311/3	10.11	III	tapping 1-¾ hole
345 "	11/8/00	20	10					10	10	50	381	325/70	10.11	III	thro. nut.
336	19/9/00	13	8		8			16	12	7	382,608.621	343/19	14	III	
Jobbing 31	28/11/00	55	15½	15½	15½			31	27¾	50	381,566	363/95	10.11	III	
" 20	24/10/00	42	13¾		13¾			26½	19¾	53	381,615	361/34	10.11	III	
323 Spare	20/10/00	55	15	15				30	26¾	52	381,566	344/81	10.11	III	
Jobbing 16	2/10/00	27	18		18			36	27		382,615	344/80	14	=	
334 Spare	1/10/00	55	15	15				30	26¾	52	381,566	344/55	10.11	III	
334	28/9/00	55	21¾	6¾				28¾	27	51	381,566	344/6	10.11	III	
333	19/9/00	55	44¾	14¾				59	55¾		381,566	341/33	10.11	=	
333 Spare	15/9/00	55	27¾	5¾				32¾	31¾	42	381,561	341/21	10.11	II	
336	19/9/00	45	13¾	13¾				26¾	23¾	48	393,566	343/5	10.11	III	
337	18/9/00	45	16	16				32	28	37	393,566	342/67	10.11	II	
			etc.						etc.				etc.		

Job Register Number
46 Shrinking webs on to pin and coupling ends.
Driving in and dressing shaft locking keys.

Part of Engine. Crank Snaft.
Operation. Fitting.

Eng. No.	Date Finished	Hours Allowed	Hours taken						Prem Time	%	Workman's Nos.	Job Line No.	Job No.	Class Mark	Remarks
			Jour.	S.App.	J.App.	Boys	Labs.	Total							
331.	30/3/00	132	101¼		44¾			149	126¼	4	298,462, 428,405	253,23	46	—	4 Cranks(1 Spare)
330.	12/4/00	99	47¾		4			52¾	50¼	49	298,462	269,70	46	III	3 do.
335 (Spare)	25/4/00	40	19¾		16			36	27¾	30	298,458	273, 4	46	II	1 do. In 1 piece
332	13/6/00	33	22¾		13			35¾	28¾	13	392,607	289,87	46	I	1 Crank
332	5/5/00	66	51¾		52			104¼	78		392,607	288,29	46	=	2 do.
333	7/6/00	33	15		12			27¾	21	36	392,607	289 45	46	II	1 do.
336	26/6/00	64½	34¾		31			66	50¾	21	392,573	290.77	46	III	3 do.
333	31/7/00	33	15¾		16			31¾	24	29	392,613	310,99	46	II	1 do.
334	3/8/00	27	11		11			22¾	16½	38	392,613	311,32	46	III	1 do.
337	2/8/00	64¾	27		27			54	40½	35	392,613	311.6	46	III	3 do.
Jobbing 402	27/7/00	18	10½		10			21	15¾	12	392,613	310,77			Shrinking 2 webs on to crankshaft.
" 467	26/7/00	28½	20¼		19			40	30¾		392,613	310,38	46	—	3 Cranks in 1 piece.
" 468	17/8/00	21	7¾		7			15½	11¾	44	392,613	326,42	46	III	1 Crank
336/7 Sp.	20/8/00	43	19¾		20			39¾	29¾	30	392,613	226,51	46	II	2 do.
334	21/8/00	54	23¾		23			47	35¾	34	392,613	327,1	46	III	2 do.
W.O. 333	24/10/00	43	26¾		21			50¾	38¾	10	392,613	361,12	46	I	2 do. (Extra work 4 hrs
Jobbing 4	5/10/00	32	14		14			28	21	34	392,613	346,30	46	III	3 Cranks in 1 piece.
340	27/11/00	90	58½	3½	53			115½	88	11	392,574 607.	363,48	46	I	3 Cranks
343/4	6/12/00	150	59½		55½			115	87¾	42	{392,613} {607.636.}	364.4	46	III	6 do.
338	13/18/00	35	15¾	7¾	8¾			30¾	24¾	29	{392,559 607.	364.66	46	III	1 do.
338	25/1/01	70	44	1¾	86			76	60½	14	392,567. 604,607.	364,71	46	II	2 do.
339/41	24/4/01	33	10¾		10			20¾	15¾	53	392,630	441,13	46	III	1 do.
339/41	15/4/01	165	63¾		69			133¾	98¾	40	392,602. 611.	444,18	46	II	5 do.

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TABLE 4 CONTINUED. PAGES FROM JOB DATA BOOK.

separate job in the manufacture of a marine engine, from the time the castings and forgings come into the works until the ship leaves after her trial trip, is registered in this book.

"The Job Data Book [Table 4.—Ed.] is a record of the work done on each article and this book now contains a most complete and miscellaneous collection of data in connection with the manufacture of marine engines and of other work. All whitewashing and painting, shifting of machines, laying down concrete floors, shifting of material from place to place, and many other operations for which, not so long ago, it would have been impossible to fix a time, are now recorded in the Job Data Book."*

*The manner of adjusting journeyman's and apprentice's time on the same piece of work in sections 3 and 4 of this table is apparently by adding to the journeyman's time three-quarters of the senior and one-half of the junior apprentices' time.—Ed.

Another matter which I may mention here is that we have the card system to a very large extent throughout our works, and we have often discussed the question of keeping the articles mentioned in Table 4 on cards instead of in a book, but my own notion is that the book is the more suitable of the two, as by a glance at a given page we can compare the times taken for similar articles without searching among cards for them.

I made no mention in my paper of the column [in Table 4] headed "Class Mark." The meaning of these symbols is:

I = Fair.
II = Good.
III = Very very good.
$\overline{III}$ = A record.
—— = Indifferent.
=-= = Bad.
=== = Very bad.

Indifferent is generally taken as meaning that the man has taken the time he is allowed. When these cases occur they are investigated right away. Very often these indifferent, bad and very bad cases happen when a new man is brought in, sometimes when a job is done for the first time, sometimes when a man has been kept waiting for a crane or a breakdown has happened to the machine. Generally speaking, we keep a record of these cases and the reason why the men have exceeded the time allowed them. I do not think that anyone can put too high a value on the introduction of a premium system into any workshop. It seems not only to elevate the class of work turned out, but our impression is that our men, since we introduced it, have vastly improved. We do not have many changes among our machine men, but when a new man is brought in it is sometimes several weeks or even several months before he equals our records.

What I take to be the great drawback in introducing the premium system into any workshop is the amount of personal labor in which it involves the principals of the firm. When I introduced this system, we had great difficulty in getting suitable men to take up the work in the rate-fixing department. Engineers looked upon it as timekeepers' work, but that was a trouble which we got over. Now we have two engineers who take charge of that department. There is no doubt that a good deal of money is involved in introducing it. In the rate-fixing department the labor is an extra at first over and above the ordinary timekeeping, but now our timekeeping and rate-fixing departments are merged into one, and we do not think that this department is to us a costly one. The use of jigs, gages, fixtures, etc., is clearly demonstrated and so prominently brought forward that large sums must be invested to cheapen the work. The use of powerful machines is also so obvious that a firm is greatly tempted—as we were—to throw out the old tools and replace them with new ones as we have done, but, as before stated, I do not hesitate to say that the reason a premium system is not introduced into more workshops is, as you state, the test it puts upon the capacity of the management. Professor Barr, of Messrs. Barr & Stroud, tells me that his manager—Mr. Jackson—has sent you their "Notes on the Premium System of Wage Earning." [Noted by us at page 1366.—Ed.] I think this is an excellent production. You will notice that they have adopted my system. Messrs. G. & J. Weir's system has been adopted by Messrs. Lang, the lathe makers of Johnstone. I think Messrs. Mavor & Coulson, electrical engineers, King street, Glasgow, have adopted my system, and when Mr. Pajeken and Mr. Orcutt visited our place, some time ago, Mr. Pajeken determined to introduce my system into their works—Messrs. Ludwig Loewe's at Berlin.

In your "American Machinist," page 1074 of last year, you state that you have repeatedly described the system. As a matter of fact, as far as we have ever heard, this system is entirely novel and was unheard of before I introduced it myself. I have never read—and I think I have read most of the articles that have been written on the premium system—nor have I ever met anyone who has ever heard of it before, so that I think I may claim this system of mine as an entire novelty.

[Comment upon this last paragraph will be found in the following article.—Ed.]

The Origin of the Premium Plan—A Personal Statement.

BY F. A. HALSEY.

The public has little interest in the claims of individuals to personal credit, and it is with some hesitation that I refer to the statement in Mr. Rowan's excellent article published in another column that, "so far as we have ever heard, this system is entirely novel and was unheard of before I introduced it myself." In addition to the hesitation due to the fact that the public cares little for personal claims, is that due to the desire not to do anything which may seem to antagonize one who has done so much for the premium plan as has Mr. Rowan. So far as known, he has more men working under that plan than has any other man, firm or corporation, and he has been a center of light in this matter in Glasgow, and, indeed, in all Great Britain. Not to take the matter up, however, would in effect give tacit approval to his words, and as the subject is attracting wide attention, now is the time to set things right if that is to be done at all.

Mr. Rowan is not to be criticised at all. He can hardly be expected to be familiar with the paper on The Premium Plan of Paying for Labor which I read before the American Society of Mechanical Engineers ten years ago and which may be found in Volume XII of the Transactions of that society. That paper began by classifying the various methods of paying for labor into:

The day's-work plan,
The piece-work plan,
The profit-sharing plan,
The premium plan.

The salient features of these plans were outlined. The fundamental fault of the day's-work plan was stated to be that "any increase of effort by the workman redounds solely to the benefit of the *employer*, the workman having no share in the consequent increase in production." Similarly the fundamental fault of the piece-work plan was stated to be that "any increase of effort by the workman redounds to *his own* benefit alone—the employer having no share in the consequent saving of time." These objections were pointed out to be "the exact antitheses of one another." What was said about the profit-sharing plan is unimportant, as that plan has now largely dropped from public attention. The salient faults of the day's-work and piece-work plans having been given, the salient virtue of the premium plan was stated to be that it makes a "division of the savings due to increased production between the employer and employee, but by a direct method instead of the circuitous one of the profit-sharing plan." The "essential principle" of the plan was thus described: "The time required to do a given piece of work is determined from previous experience and the workman, in addition to his usual daily wages, is offered a premium for every hour by which he reduces that time on future work, the amount of the premium being less than his rate of wages. Making the hourly premium less than the hourly wages is the foundation stone on which rest all the merits of the system." These features of the day's-work and piece-work plans were also described in my article published in the issue of this paper for March 9, 1899, from which the present interest in the subject dates, and it was stated that the premium plan "in a sense splits the difference between the day's work and piece-work plans."

Following this analysis of the different plans in the original paper, I gave the method which I had used in dividing the gains due to increased effort by the workman between the workman and his employer, as well as illustrations of the blank forms used. It would be just as unfair to limit my invention to the blank forms as to the exact method of division used. The statement of the basic idea is broad enough and clear enough, and there can be no doubt as to its meaning. The essence of the whole thing is the division of the gains between the workman and the employer, whereby, as has been described over and over again, wages go up and costs go down together.

Mr. Rowan has suggested another method of making the division. Some time ago, in these columns, Mr. Fernstrom suggested another and Mr. Ross still another, and many others are possible. These gentlemen are entitled to the credit for what they have done, but that their methods of division constitute a new system or that their methods, and all similar methods which carry out the basic idea, are not included in the premium plan as invented by me, I deny. So long as the premium per hour saved is less than the wages per hour used, the system is my

premium system and nothing else. If the premium rate equals the wages rate the system becomes, in effect, piece work, and if the premium rate exceeds the wages rate it becomes, in effect, Mr. Taylor's differential piece-work system.

The paper before the Mechanical Engineers contains, as far as I know, the first published use of the name and the first published description of the thing known as the premium plan. The invention is several years older than the paper, but the paper is the record.

If I were to apply the language of the Patent Office to this unpatented and, perhaps unpatentable, invention, the result would be as follows:

I claim:

A plan of paying for labor in which the gains due to increased production by a workman are divided between the workman and his employer.

Echoes From the Oil Country.

AT THE BOTTLING WORKS.

"I'm getting a new machine; it will be here in a few days; get out pulleys and a countershaft and hangers for me and send them up with a man to put them in place. The machine should not run less than 3,000, and 3,500 will be better. The engine runs the line shaft at 200, but it can be speeded up a little if we have to. The pulley on the machine is 6 inches diameter and 3 inches face. When can you have it ready to run?" This was a small job from the bottling works, and the machine was a bottle washer. I had never seen, or, for that matter, even heard of one; but no matter, here was an order for a shaft, two hangers and a couple of pulleys.

"You say you have a 30-inch pulley that will do to start from on the line. Well, I have a 24-inch and an 8-inch, both 1½-inch bore, and two 14-inch drop 2-inch hangers that I can babbitt down; these, with 4 feet of 1½-inch shafting, will fill the bill," I said, after looking over my stock. "I will have to balance the pulleys, as that counter will run rather fast. I guess I can have it ready to send up in the morning, and can have it ready to run by noon."

That seemed to be satisfactory and the next day found me up with the stuff and Mr. Moore, the owner, waiting for me.

"See here, now," was his greeting; "that line shaft has been giving us trouble for some time and I want you to look it over while these fellows are sticking up your hangers. You just show them where to put them."

I did look, and I found things badly out of level, and I told him it would need to be dropped about 4 inches on one end to bring things right. He walked back and forth a few times and then he started a man off to borrow some jacks to raise the building up to bring that shaft level. As it was a three-story building, I thought that rather heroic treatment, and I tried to tell him it was unnecessary.

"Ain't them things all the same length, and don't that shaft lay the same distance down from the joists, and so isn't the whole building out of level, and, anyhow, we will have it up before you are through with your job, and then I want the engine looked over while you are here."

I thought perhaps they had ways of their own at bottling works, and so I said nothing further. By the time I had everything ready the building was, in general, level, and after going over the line shaft and counter carefully, I left.

In a couple of days the owner came to the shop. The machine had come and did not work as it should, and I must come up. This was the first washing machine they had put in. It was intended to wash beer bottles. A hollow shaft revolving at a high speed contained another shaft that had rubber mounted on the end of it. When the neck of the bottle was pushed over the shaft it hit a stop and on pushing further the shaft with the rubber was advanced. As soon as the rubber was out by the end of the hollow shaft it expanded as far as the bottle would let it and at the same time a strong stream of water was squirted through the inner shaft. Moving the bottle back and forth allowed the rubber to reach every part of the bottle. This part of the machine was covered with a strong wire guard, and a barrel near by was partly filled with broken bottles.

When I got there they told me the belt came off and the bearings heated, not on my work but on the machine. Mr. Moore kindly offered to show me how it worked, but he told the man to run the engine slow. The machine sang a song I was not used to and the belt on the machine seemed to stand away from the pulleys. A crash of breaking glass drew my attention to the business end. Mr. Moore would push a bottle on carefully until it pushed against the stop; then, with a rush of water and a whirr, smash! would go the bottle. Some, being extra tough, would stand washing, some would have the neck drop off before the washing began, and one man was busy with an oil can feeding oil to the bearings.

After some talk I made out that the machine spindle was to run 3,000 turns, but as this machine had a counter on it with an 18-inch pulley running to a 4-inch on the spindle we were speeding it for about 14,000, which seemed a trifle high. The company made two styles of machines and the agent had talked both kinds and so mixed my friend up a little.

I was for taking down the counter and running direct from the line shaft, but he insisted that I put other pulleys on the counter, said he had need of a stock of pulleys and would keep those I had up. As he had lots of room upstairs, I did not argue the question, but soon had that washer singing a more civilized tune, and one that did not fill the barrel so fast with broken bottles.

W. OSBORNE.

Ball Bearings for Heavy Machinery.

A series of tests of ball bearings under heavy pressure was conducted some time ago on behalf of the German Arms and Munition Factory, of Berlin, by Messrs. Heibeck and Riebe, the latter being engineer of the factory. The results have been published by Mr. Heibeck in the "Zeitschrift des Vereines deutscher Ingenieure," from which a brief abstract has been prepared for the Institution of Civil Engineers, London.

Hertz and Auerbach's researches, it is stated, were inadequate to solve the important questions involved in the experiments. A special device was employed whereby three balls, one on the top of the other, were subjected to vertical pressure, the central ball was also in another series of experiments replaced by a flat circular plate whose periphery was the same as that of the two other balls. The observations were by a reflecting apparatus which magnified 500 times. Pressure was applied by a 5-ton press which was of a special construction. The diameter of the balls ranged from ⅜ to 1⅜ inches. The results are given in two sets of tables (I. for balls, and II. for balls and plane surfaces).

The author next treats of the theoretical determination of the amount of friction, then describes the special apparatus employed by him in ascertaining the same practically. The result of experiments with various kinds of bearings showed that the best form for heavy work was two rings, the inner surface having a groove the depth of which was two-thirds the radius of the balls.

With pressures of 2,204 to 6,614 pounds and 65 to 780 revolutions per minute, the coefficient of friction varied very little indeed, and averaged 0.0015. Up to a pressure of 10,800 pounds with 780 revolutions per minute, the balls and bearings were faultless. For the past year all the ball bearings manufactured by the Berlin Arms and Munition Factory have been constructed on the basis of these experiments, which were concluded in March, 1899. Since then bearings of greater size have been made and worked under a pressure far exceeding the above, and this is due to the care and attention paid to the perfection of the material and workmanship of all parts of the ball bearings.

Experiments on the Flexure of Beams—Discovery of New Laws—IV.

BY ALBERT E. GUY.

EXPERIMENTS (CONTINUED).

The results of experiments performed on nine bars of various sizes, but all of rectangular section, are shown in the following tables. In table 1 we have the dimensions of the bars as well as the moments of inertia and the moduli of elasticity. In table 2 are given the results of the tests on bars held horizontally at one end and loaded at the other. The product

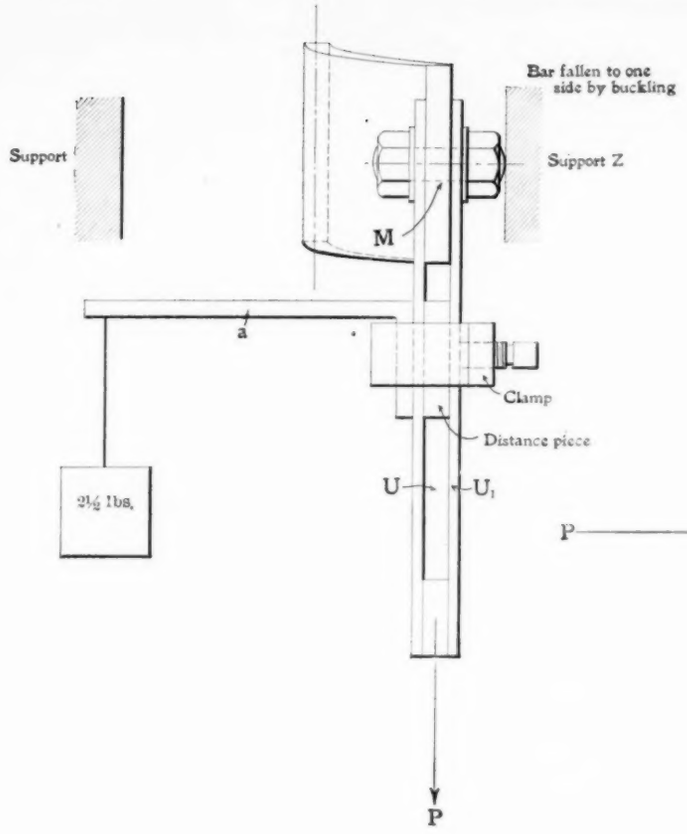

FIG. 7. THE ACTION OF AN ECCENTRIC LOAD.

But after a careful investigation it was found that the thin wooden strips U and U_1, Fig. 5, which were fastened to the specimen by a bolt passing through the center of suspension M, although very lightly pressed against the bar, caused this latter's extremity to remain vertical, thus

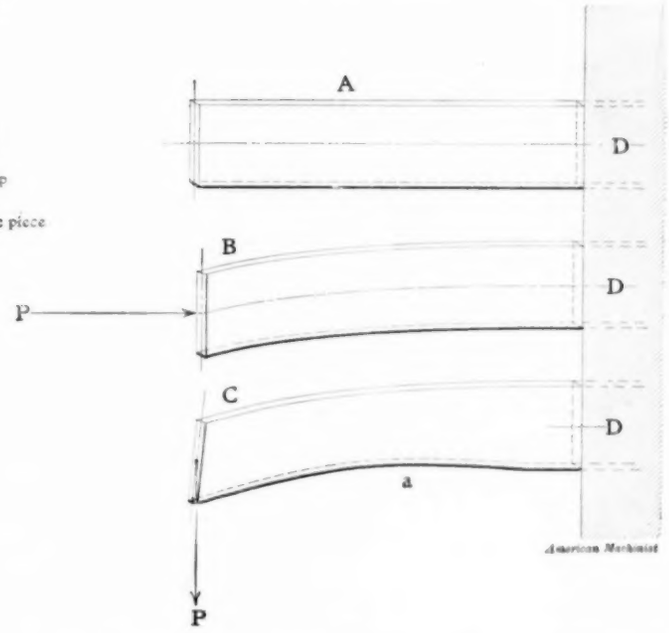

FIG. 8. FAILURE OF A BAR UNDER COMPRESSION AND BENDING FORCES.

$P L^2$ of the load by the square of the length being almost a constant quantity, the first law is verified in all the tests, but the second and third laws are far from being as clearly established.

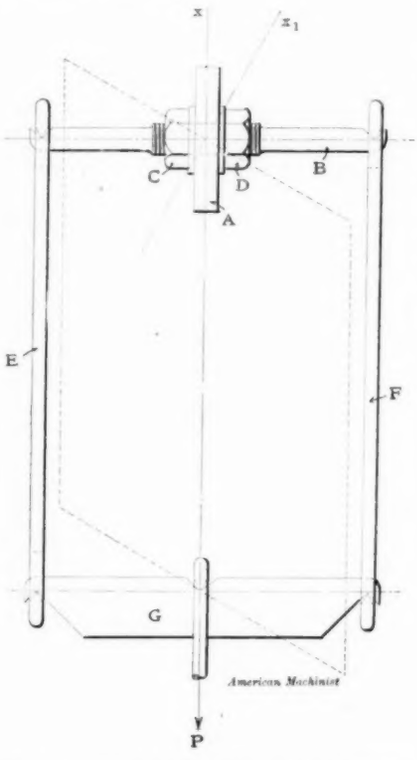

FIG. 9. METHOD OF SUSPENDING LOAD GIVING BAR ENTIRE FREEDOM TO BUCKLE.

It would seem, so far, that the laws need to be modified in a fashion similar to that employed by Professor Hodgkinson in his experiments on columns.

The tests with the bars inclined at an angle of 30 degrees with the horizontal are recorded in table 3. Here again the first law is clearly verified, but the other two are not conclusively proven.

In table 4 are recorded the tests for bars Nos. 1, 2, 3 and 6 inclined at 45 degrees, and for bar No. 3 inclined at 60 degrees. Great difficulty was experienced in these last tests, in determining the exact loads causing the buckling; in fact, with the 60 degrees inclination the results were so erratic that they did not seem to be governed by any definite law. Each trial was a failure and I felt very much discouraged.

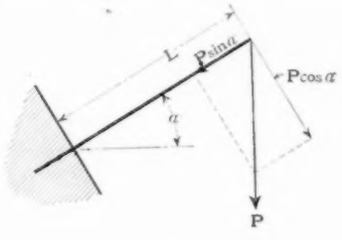

Fig. 10

preventing to a certain extent the bar from assuming the curvature generally produced by the buckling.

Since the horizontal and 30 degrees tests appeared to be sufficiently accurate, they alone were entirely carried out. The 45 degrees tests were not quite completed and those at 60 degrees were abandoned for the time being. Then the bars were tested in the vertical position, the results also being shown in table 4. Here the three laws are entirely verified, and the results, on being compared, are almost identical with those indicated by the formula of Euler, viz.: $P L^2 = \frac{\pi^2}{4} E I$.

The ratios between actual and theoretical results are shown at the bottom of the tables. Consequently, it must be admitted

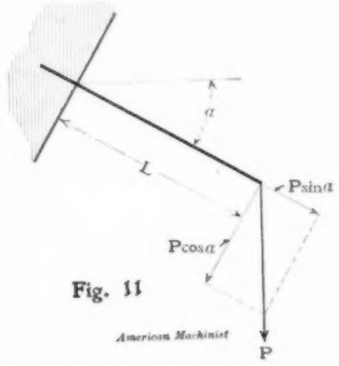

Fig. 11

INCLINATION OF BAR ABOVE AND BELOW THE HORIZONTAL.

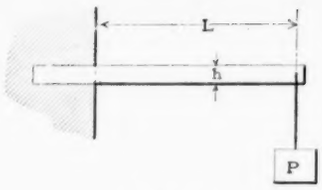

Fig. A

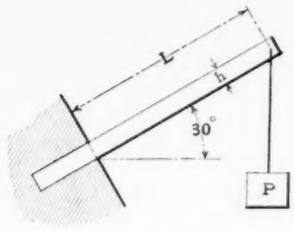

Fig. B

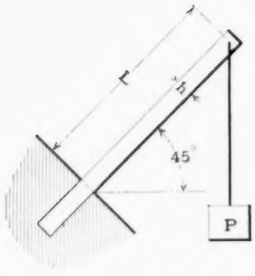

Fig. C

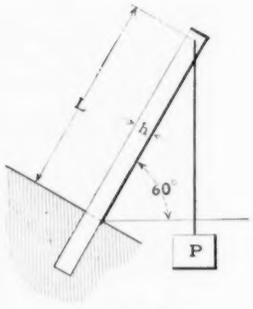

Fig. D

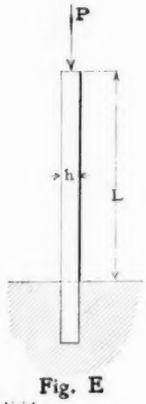

Fig. E

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REFERENCE FIGURES FOR THE TABLES OF TESTS.

that Euler's formula is correct, since it can be proven by such simple experiments as those just described. It is worthy of remark that the vertical tests were made under perfect conditions: *the bar being firmly held at the base and the load made to act axially in such a manner as not to hinder in any way the bar from assuming the natural curvature due to buckling.*

In order to investigate the cause of the failure of the other tests, a bar was placed at 60 degrees and loaded until it buckled and fell to one side, when it rested against support *Z*, Fig. 7. Then an arm *a* was clamped to the strips *U* and U_1 near the top, and gradually loaded until the bar straightened slowly, and finally bending abruptly fell to the other side against a support, being thus prevented from breaking. This bar was No. 3, having for dimensions $b = \frac{1}{4}$ inch, $h = 1$ inch. For a length $L = 18$ inches, it buckled under a load of 14¾ pounds, with the suspension bolt at *M* loosely fitted. This bolt being very firmly tightened, the bar straightened a little and 2¼ pounds were added before buckling occurred anew. Then the arm *a* being adjusted in place and loaded with about 2¼ pounds, the bar again straightened slowly and with a slight increase of the load it fell on the other side against the support. This little experiment, repeated on several bars, proved conclusively that a bar can be made to bear a greater load if its loaded end is prevented from turning about its axis than it would carry were this end free to oscillate. This eccentric load simply amplified the guiding action of the strips *U* and U_1.

Fig. 8 represents at *A* a straight bar held at the end *D*. At *B* the same bar under axial compression is bent laterally, the curve assumed by this axis being a sinussoid combined in the same horizontal plane as the originally straight axis. This curve is the first of the nine kinds of plane elastic curves found by Jacques Bernouilli (A. D. 1694) and analyzed by Euler. It is seen that the vertical axis of the loaded end remains parallel to that of the bar in a state of rest. At *C* the bar is subjected to a bending effort and buckles in the compression part. Just before buckling occurred the bar was longitudinally straight as at *A*, but vertically bent, since the bending force necessarily caused a certain deflection. Consequently, the neutral plane of the bar affected a parabolic curve. With an increase of the load the compression part buckled and was curved, as shown at *a*. From the fact that the bar is thrown to one side it is easily seen that the two lower edges are no longer equally strained. The right edge is under a greater compression and consequently shortened, but the left is somewhat relieved and therefore relatively elongated. The curve assumed by the upper edges is very much like that at *B*, and has not the abruptness seen at *a*. *It results from this that the major axis of the loaded end is no more vertical, and the bar is actually twisted.* Therefore any force which can prevent this twisting must necessarily increase the carrying capacity of the bar, or, in other words, must insure to a greater degree the elastic equilibrium of the solid.

It remains now to find the true laws governing the elastic equilibrium of a solid

No.	b	h	I	I_1	E
1	⅛″	1″	0.01042	0.00016276	1265000
2	3/16″	1″	0.015625	0.00054932	1226400
3	¼″	1″	0.02083	0.0013025	1305150
4	⅛″	1½″	0.035156	0.00024414	1292450
5	3/16″	1½″	0.052734	0.00082397	1361750
6	¼″	1½″	0.070312	0.0019531	1278750
7	⅛″	2″	0.08333	0.00032552	999455
8	3/16″	2″	0.125	0.00109864	1488200
9	¼″	2″	0.1666	0.002605	1315050

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TABLE I. DIMENSIONS, MOMENTS OF INERTIA AND MODULII OF ELASTICITY OF BARS TESTED.

	No. 1		No. 2		No. 3		No. 4		No. 5		No. 6		No. 7		No. 8		No. 9	
L″	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2
10	6¾	675.					11¼	1150.	33.5	3350.								
11	5¾	695.75					9.75	1179.75	27.5	3327.5								
12	4¾	684.	14¾	2124.			8.25	1188	23.	3312.			9.75	1404.				
13	4	676.	13¾	2154.75			7.	1183	20.75	3506.75			8.	1352.				
14	3½	686.	10¾	2107.			6.	1176	17.25	3381.	36.5	7154.	7.	1372.				
15	3	675.	9¼	2081.25			5.25	1181.25	15.	3375.	31.75	7143.75	6.25	1406.25	21.	4725.		
16	2⅝	672.	8⅛	2080.			4.625	1184	13.25	3392.	27.75	7101.	5.5	1408.	17.75	4544.		
17	2¼	650.25	7¼	2095.25	16.91	4886.99	4.	1156	11.5	3323.	24.5	7080.5	4.625	1336.625	15.75	4551.75		
18			6½	2106.	15.41	4992.84					21.75	7047.	4.125	1336.5	14.50	4698.	31.	10044.
19			5¾	2075.75	13.66	4931.26					19.75	7129.75	3.625	1308.625	13.25	4783.25	27.25	9837.25
20			5¼	2100.	12.41	4964					17.75	7100.	3.375	1350.	11.75	4700.	24.75	9900.
21			4¾	2094.75	10.91	4811.31					16.	7056.			10.50	4630.5	22.50	9922.5
22					9.91	4796.44					14.5	7018.			10.	4840.	20.50	9922.
23					9.16	4845.64									8.75	4628.75	19.	10051.
24					8.66	4988.16									8.	4608.	17.	9792.
25																	15.75	9843.75
26																	14.50	9802.
Average		676.75		2101.875		4902.08		1174.74		3370.96		7092.8		1361.55		4670.95		9901.61

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TABLE 2. RESULTS OF TESTS ON BARS HELD HORIZONTALLY AT ONE END AND LOADED AT THE OTHER, AS IN FIG. A.

loaded transversally at one end and free to assume any consequent curvature. If at *C*, Fig. 8, the load is applied on the upper face of the bar, there will result an increased twisting and the bar will carry less load. If the load is hung from the lower face, the twisting will be lessened and the bar will be guided vertically, as with the strips *U* and U_1, thus increasing the carrying capacity.

Consequently, the point of suspension of the load at the end of the bar must be at the center of gravity of the section and must remain there. This condition can be fulfilled by employing the device illustrated by Fig. 9, where *A* is the end of a bar through which passes a rod *B*, made fast to the bar by means of the nuts and washers *C* and *D*. The ends of the rod are hook-shaped, and therefrom are suspended two rods *E* and *F* supporting the beam *G*. The centers of the hooks of rod *B* are equidistant from the center of gravity of the section *A;* the load *P* is applied at middle of beam *G*, and rods *E* and *F* are parallel. The whole system can oscillate freely, the points of suspension being all knife edged. The direction of the load passes therefore through the center of gravity of the section, and does so regardless of the inclination of the axis *x* of the bar—as, for instance, when the bar being twisted this axis occupies the position x_1, Fig. 9.

With this apparatus the bars were again tested in the four positions previously described, and, curiously enough, *were found to give way by buckling under exactly the same loads that caused the buckling in the fifth or vertical position.* Thus, bar No. 5, with a length of 10 inches, gave way in any of the five positions under a load of 26¼ pounds. The load was not in the full sense of the word exactly 26¼ pounds, but the variation was less than ⅜ of a pound one way or the other. This variation is, of course, insignificant and well within the permissible limits. All the bending tests were successful, but the thin bars Nos. 1, 4 and 7, being only ⅛ inch thick, offered much difficulty in the vertical position, because the load could not be applied axially.

We must now find the reason why a bar of iron of given length buckles under a certain load, as well when held vertically as horizontally, or in any intermediate position between these two.

The problem of the strength of columns properly belongs to the domain of higher mathematics. It has been solved by Euler, Lagrange, Poisson and several other great mathematicians. It is consequently impossible to present an elementary solution of it here, and we must admit the correctness of Euler's formula since experiments prove it; we must also admit, for similar reasons, that the same laws govern the equilibrium of a horizontal beam subjected to a bending effort. Then we can easily explain the other cases. In Fig. 10 a beam *L* firmly held at one end is inclined at an angle α from the horizontal and sustains a load *P* applied at the other end. The force *P* can be resolved into two others: One ($P \cos. \alpha$) acting perpendicularly to the length *L* produces a bending effort whose moment is $P \cos. \alpha \,.\, L$; the other $P \sin. \alpha$, is a force of compression acting axially on the solid. It is very important to remark that $(P \cos. \alpha)\, L = P(L \cos. \alpha)$. The first member of this equation is the product of the force $P \cos. \alpha$ by the length *L*, whereas the second member is the product of a force *P* by the length $L \cos. \alpha$. This second is more proper than the first, judging by the definition of the term *moment* of a force. Thus a moment is the product of a force by its lever arm. Here the force is *P*, the arm is the projection $L \cos. \alpha$. If the axial force alone was sufficient to cause the buckling of the prism, we would have

$$(P \sin. \alpha)\, L^2 = \text{constant};$$

but this expression is not correct, for we can also prove that

$$(P \sin. \alpha)\, L = P\, (L \sin. \alpha),$$

and the results would differ widely were we to introduce one or the other of these terms into the previous equation. But if the question is considered in another way

	No. 1		No. 2		No. 3		No. 4		No. 5		No. 6		No. 7		No. 8		No. 9	
L″	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2
10	6.25	625.					9.5	950.	20.5	2050.								
11	5.125	620.125					7.75	937.75	25.5	3085.5								
12	4.	576.	13.	1872.			6.5	936.	22.5	3240.			8.25	1188.				
13	3.5	591.5	11.	1859.			5.75	971.75	18.75	3168.75			7.25	1225.25				
14	3.	588.	9.5	1862.			5.	980.	16.25	3185.	32.	6272.	6.	1176.				
15	2.5	562.5	8.25	1856.25			4.25	956.25	13.5	3037.5	27.25	6131.25	5.125	1153.125	19.5	4387.5		
16	2.25	576.	7.25	1856.			3.75	928.	12.25	3136.	24.	5888.	4.5	1152.	16.5	4224.		
17	2.	578.	6.25	1806.25	14.75	4262.75	3.25	939.25	11.25	3251.25	21.5	6213.5	4.	1156.	14.75	4262.75		
18			5.5	1782.	13.25	4293.					20.	6480.	3.5	1134.	13.75	4455.	27.	8748.
19			5.	1805.	11.75	4241.75					18.	6498.	3.125	1128.125	12.5	4512.5	23.75	8573.75
20			4.5	1800.	10.25	4100.					15.25	6500.	2.75	1100.	11.25	4500.	21.	8400.
21					9.25	4079.25					13.75	6063.75			9.75	4299.75	19.25	8489.25
22					8.375	4053.5					12.75	6171.			8.75	4235.	18.	8712.
23					7.625	4033.625									8.	4232.	16.5	8728.5
24					7.	4032.											15.	8640.
25																	13.75	8593.75
26																	12.75	8619.
Average		589.64		1832.77		4136.98		949.87		3131.75		6246.38		1156.94		4345.38		8611.50

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TABLE 3. RESULTS OF TESTS ON BARS HELD AT AN ANGLE OF 30 DEGREES, AS IN FIG. B.

	← See Figure C →								See Figure D		← See Figure E →									
	No. 1		No. 2		No. 3		No. 6		No. 3		No. 2		No. 3		No. 5		No. 6		No. 8		No. 9	
L″	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2	P	PL^2
10	6.	600.													26.75	26.75						
11	5.	605.													24.375	2828.375						
12	4.25	612.	13.75	1980.							12.25	1764.			19.	2646.						
13	3.75	633.75	11.5	1943.5							10.25	1732.25			16.125	2725.125						
14	3.25	637.	9.5	1862.							8.75	1715.			13.75	2695.	30.75	6086.				
15	2.75	618.75	8.5	1912.5			29.25	6581.25			7.5	1687.5			12.	2700.	27.	6075.	18.	4050.		
16	2.375	608.	7.5	1920.			25.	6400.			6.625	1696.			10.625	2720.	23.75	6080.	16.5	4224.		
17	2.	578.	6.5	1878.5	16.	4624.	22.5	6502.5	17.75	5129.75	6.	1734.	14.75	4262.75	9.625	2781.625	21.25	6141.25	14.5	4190.		
18			5.5	1782.	13.5	4374.	20.5	6642.	15.25	4941.	5.125	1660.5	13.25	4293.			19.	6156.	12.75	4131.	26.25	8505.
19			5.	1805.	12.25	4422.25	18.5	6678.5	13.75	4963.75	4.75	1714.75	11.75	4241.75			Broken		11.5	4151.	23.5	8483.5
20			4.5	1800.	11.25	4500.	16.5	6600.	12.5	5000.	4.25	1700.	10.75	4300.					10.25	4100.	21.5	8600.
21					10.	4410.	15.	6615.	11.25	4961.25	4.	1764.	9.5	4189.5					9.25	4079.25	19.625	8654.625
22					9.	4356.	13.75	6655.	10.25	4961.			8.625	4174.5					8.375	4053.5	17.875	8651.5
23					8.5	4496.5			9.75	5157.75			8.	4232.					7.75	4099.75	16.25	8596.25
24					8.	4608.			9.	5184.			7.625	4392.					7.	4032.	15.	8645.
25																					13.875	8671.875
26																					12.75	8619.
Average		611.56		1875.94		4473.84		6584.28		5037.3		1716.8		4260.68		2721.39		6097.65		4111.05		8602.97
From Euler's formula – PL^2 – Constant –												1662.3		4186.7		2768.4		6162.2		4034.2		8449.5

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TABLE 4. RESULTS OF TESTS ON BARS HELD AT ANGLES OF 45 AND 60 DEGREES AND VERTICALLY, AS IN FIGS. C, D AND E.

we can make the results agree with the experiments. Thus, by assuming that the force P tends to compress a solid of length $L \sin. \alpha$, and to bend another of length $L \cos. \alpha$, we must have:

$$P\ (L \sin.\ \alpha)^2 = \text{constant}.$$

If the bending alone caused the buckling we would have:

$$P\ (L \cos.\ \alpha)^2 = \text{constant};$$

but, since the combination of the efforts caused the buckling, and since the load applied is equal to that which buckled the same solid of length L in the vertical as in the horizontal position, it becomes evident that the efforts must be added. Hence

$$P(L \cos.\ \alpha)^2 + P(L \sin.\ \alpha)^2 = \text{constant}; \quad (18)$$

or $$P L^2 (\sin.^2 \alpha + \cos.^2 \alpha) = \text{constant}.$$

But $\sin.^2 \alpha + \cos.^2 \alpha = 1$, hence for any position between the vertical and the horizontal (above the latter) we have:

$$P L^2 = \text{constant},$$

as found by experiment.

When the bar is placed below the horizontal, as in Fig. 11, the force P may again be resolved into two others, one ($P \cos.\ \alpha$) perpendicular to the axis of the bar, producing a bending effort whose moment is $P \cos.\ \alpha \,.\, L$; the other force ($P \sin.\ \alpha$) is axial and tensile. Since a tensile force cannot produce buckling, but, on the contrary, tends to prevent it, its effect is negative and, as in the present case, a bar nevertheless may buckle, it follows that it does so under the combined efforts of the components of force P. Therefore, we have again:

$$P(L \cos.\ \alpha)^2 + [-P(L \sin.\ \alpha)^2] = \text{constant},$$

or $$P L^2 (\cos.^2 \alpha - \sin.^2 \alpha) = \text{constant}. \quad (19)$$

This shows clearly that the greater the angle α the lesser will be the tendency of a bar to buckle. Furthermore, this tendency will be maximum with the bar horizontal, when $\sin.\ \alpha = 0$, and minimum with $\alpha = 45$ degrees, when $\sin.\ \alpha = \cos.\ \alpha$ and P becomes ∞. With a still greater angle, the tensile force being superior to the bending, no buckling can take place.

It is easy to prove this experimentally by using the apparatus No. 1, Fig. 5, in which a bar can be made fast at one end and inclined, for instance, at an angle of 30 degrees below the horizontal. If we use No. 2, 20 inches long, the load suspended from the free end must be 4¼ pounds to produce buckling. We found at first in the vertical tests, and afterward in the modified angular tests, that $P L^2 = 1700$; hence we must have:

$$P_1 L^2\ (\cos.^2 30^\circ - \sin.^2 30^\circ) = 1700$$

$L^2 = 400$; $\cos.^2 30^\circ = 0.75$; $\sin.^2 30^\circ = 0.25$.

Hence $$P_1 = \frac{1700}{400 \times 0.25} = 8.5 \text{ pounds}.$$

In reality, the weight required in the test is a little more than 8⅞ pounds. This excess is due to the fact that, as soon as the load is applied, it causes a deflection of the bar, which augments the angle α. For thin wooden specimen the deflection is very great and must be taken into account. Thus, the load required is also slightly greater for the horizontal than for the angular and vertical tests.

We may write for any angle α the general formula:

$$P L^2 (\cos.^2 \alpha + \sin.^2 \alpha) = \frac{\pi^2}{4} E I, \quad (20)$$

in which the sign (+) must be employed when the component of P is a compressive force, and sign (—) when this component is tensile.

(To be continued.)

On the Science of Steam-Making.*

BY JOHN C. PARKER.

[The following paper presents an analysis of the theoretical conditions for securing maximum economy in steam-making which, we believe, will be recognized as fundamentally sound by all who have given attention to the subject of the transfer of heat. The flow of the heat-giving and the heat-absorbing media in opposite directions is practiced in many kinds of apparatus and is, in fact, recognized in the economizer as applied to boilers, the principle of this apparatus being the placing of the entering water in connection with the leaving flue gases. However sound the theory, it must be owned that when applied to boilers it leads to a construction that is startling in the manner in which it trespasses upon what are considered established features if a successful boiler is to be the result. The ideas outlined have, however, gotten beyond the paper stage—a boiler built on these principles having been in use at the Roach Shipyards, Chester, Pa., since April, 1900. These boilers were made by the Parker Engine Company, 1041 Drexel Building, Philadelphia.—Ed.]

The wastefulness of the steam engine was the prime cause of its scientific development, whereas the boiler presented no such economic problems. The comparatively high economic performance of the boiler under adverse conditions has retarded scientific development, and its progress has been entirely empirical.

To make the steam engine operative certain well-defined principles must be followed. It is not so with the boiler; any kind of an apparatus, no matter how oddly it may be constructed, will produce steam nearly as efficiently as the most approved design. It has been so easy to make steam that there has been little incentive toward scientific treatment of the problem.

The physical conditions involved in the scientific generation of steam can be graphically shown by a diagram, Fig. 1.

The vertical scale represents temperatures above 0 degree Fahr., 2,500 degrees Fahr. is taken to indicate the initial temperature of combustion and the curve illustrates the fall in temperature of the gases in their passage to the flue, where they escape at 600 degrees Fahr. The line at 362 degrees Fahr. represents the boiler temperature due to the pressure (in this case 143 pounds) and the difference in temperature between the boiler and the flue gases is thus 238 degrees.

Since, owing to rigidity of construction, present practice aims to secure equal temperature throughout the boiler, the line at 362 degrees will be straight, and, since

*Abstract of a paper read before the Engineers' Club of Philadelphia, April 6, 1901.

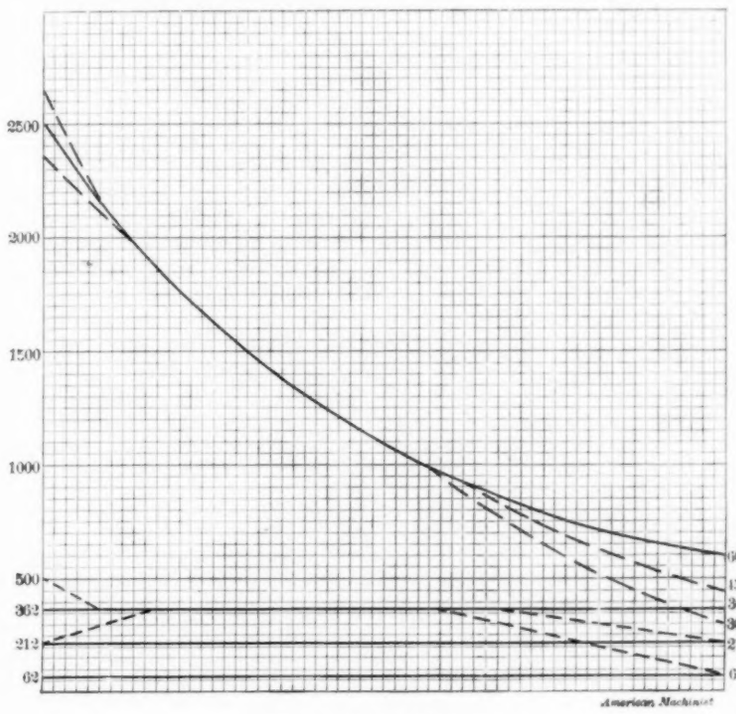

FIG. 1. HEAT DIAGRAM.

there can be no conduction of heat from a lower to a higher temperature, it would be impossible to reduce the temperature of the gases below 362 degrees.

But suppose we are not tied down to a rigid structure, and are free to have the different parts of the apparatus at different temperatures without affecting each other. We will cause the feed water to flow in the opposite direction to the gases. If the feed comes from a heater at 212 degrees Fahr., that end of the evaporation line will be inclined (slightly curved) from the starting point at 212 degrees Fahr. until 362 degrees is reached, when it will be horizontal to the point at which superheating begins, where it will again be inclined, but very much more toward the vertical, both on account of the low specific heat of steam and the great difference in temperature.

With the same difference in temperature between the flue gases and the water as before (238 degrees), the flue temperature would be reduced to 450 degrees, which amounts to a saving of 12.4 per cent. If the feed water happened to be at 62 degrees, the flue temperature would be reduced to 300 degrees (with the same difference), which would mean a saving of 23.39 per cent. In this case the temperature of the gases is lower than the temperature of the steam, and this illustrates how heat may be transmitted from a lower to a higher temperature by convection.

It will be observed that superheat could not be added under these conditions at the cool end, but it might be very easily at the other end, with the result of increasing the initial temperature of combustion, and so adding to the economy at both ends.

If the water came in at the hot end of the diagram the rise in temperature would be more rapid, as indicated by the dotted line, but the initial temperature of combustion would be lowered as shown.

It must be evident that to secure the maximum transmission of heat from the gases to the water they must flow in opposite directions, and evaporation must be completed in a single circuit. If any water is recirculated after being raised to the boiling point, it must necessarily reduce the economy by raising the feed temperature and so reducing its capacity for absorbing the heat of the gases; furthermore, superheating would be impossible and the initial temperature of combustion would be lowered.

It is also plain that, while the transmission of heat is as the square of the difference in temperature, the difference will not be maintained except in proportion to the rapidity of the flow which must be impelled by a constant force.

The diagram demonstrates that the functions of the economizer, the boiler, and the superheater are but separated parts of a single progressive operation which can be more perfectly accomplished in one apparatus.

This is in effect an application of the regenerative process first applied to the air engine about the year 1816 by the Rev. Dr. Stirling, and subsequently improved and modified by Mr. James Stirling, Captain Ericsson, Mr. Siemens, and others. Attempts were made to apply it to steam generating in France by Belleville in 1856, and in America by Herreshoff about 1878. Mr. Yarrow has made an application of it to his type of boiler quite recently, and he presented an excellent paper on the subject before the British Institute of Naval Architects at the March meeting, 1898.

Belleville and Herreshoff both started on the basis that the flow of the water and gases should be opposite, and evaporation progressively secured in a coil. Both used a pump to maintain the flow, and to that fact their failure may be ascribed.

Belleville assumed that the trouble was due to there being no water in the tubes in direct contact with the flames, and so abandoned his correct principle. He resorted to the common practice of supplying the water to the hot end of the coil, but his troubles were not ended. He made no material progress until he discarded the pump and adopted a gravity circulation. It took him twenty-three years to develop an operative boiler, and that he did so finally, on an incorrect principle, is a remarkable tribute to his personality.

The fact is that after two centuries of empirical progress we find ourselves at the opening of the twentieth century with the steam-generating problem still before us. The "boiler question" has been peculiarly acute during the past decade, particularly in Great Britain, and it would seem as if important results were to be expected, in view of the amount of attention which is being given to the subject.

So far as principle goes, we are making steam to-day by the same process adopted by Hero, of Alexandria, 2,000 years ago—*i. e.*, we boil water in large quantities and draw off the steam from the same chamber—both very improper practices. We may have stuck some flues through the water chamber to increase the heating surface, or perhaps we have divided up the water space into a mess of tubes, but so far as principle goes, Hero was not one whit behind us in the art of steam making.

While pressures were low the boiler was reasonably satisfactory; but when the pressure rose above the atmosphere, a new condition was introduced: the pressure was no longer constant and explosions began to be known. As weakness developed it was met at the visible point, and a stay was inserted, a tube beaded over, or a furnace corrugated. Safety became the fundamental idea in boiler design to the exclusion of correct principles, with the result that neither has been attained. The comparative safety of the boiler to-day is more of a tribute to the steel maker than to the designer.

Only one important conclusion has been reached in the steam-making problem in a century of remarkable scientific progress in other directions. The idea has become almost universal that a free circulation of the water is essential to the safe generation of steam, and that idea is absolutely incorrect.

The primordial condition for the safe generation of steam is a *constant flow* of the water and steam in one direction. This condition has never been fulfilled. The constancy of the flow is affected in two ways: by forcing the fire until the water is driven in the wrong direction, and by the lifting effect due to falling pressures, which produces a like result.

While the lifting effect due to falling pressures has been well known, the extent of its influence on the motion of the water and steam has never been fully appreciated; in fact, most of the troubles connected with steam-making can be traced directly to this cause.

It is a well-seated belief among engineers that water must be in continual contact with the surfaces exposed to the radiant heat to prevent damage; but how water is to be in continual contact with a square foot of surface which is evaporating enough water to entirely cover it with a layer of steam from ⅛ inch to ¼ inch thick once every second has not been explained. Water will not prevent overheating without motion, while steam is most efficient in carrying off the heat if in rapid and constant motion in one direction. Rankine states (p. 261) that the most rapid convection of heat is that which is effected by means of a cloudy vapor, which combines the mobility of a gas with the comparatively greater conducting power of a liquid.

The principal conditions involved in the evolution of a satisfactory steam generating apparatus may be stated as follows:

In a perfect generator—

1. The water and gases must flow in opposite directions to secure the maximum transmission of heat.

2. The flow must be constant and at maximum speed to obtain the highest efficiency of the surface and prevent overheating.

3. There must be no circulation of the water; evaporation must be secured in one circuit.

4. The steam must flow directly from the hottest part of the furnace to the steam reservoir without passing through water.

5. The steam supply must be separated from the water so that priming, foaming, or lifting will be impossible.

6. There must be sufficient steam and water room to prevent excessive fluctuations in pressure and water level.

7. The internal surface must be kept clean automatically and the external surface must be perfectly accessible.

8. There must be no fluctuations in the temperature of the metal; feed water on hot surfaces must be made impossible.

9. There must be perfect flexibility to permit independent expansion of each part.

10. The apparatus must be simple, with

fewest and best joints, and arranged to permit ready access to every part.

11. The apparatus must be absolutely reliable in operation under adverse conditions, with ordinary care.

12. The apparatus must be durable, without frequent repairs, and with freedom from leaks.

The essential elements of a steam-making apparatus designed to fulfill the foregoing conditions are shown in the evaporation diagram, Fig. 2.

There is a dry steam chamber, a water chamber beneath it, a tubular passage extending downward from the water chamber, the lower end of which is connected to the dry steam chamber by a direct upcast passage. An opening between the chambers, controlled by a non-return valve, completes the circuit, and equalizes the pressure throughout the apparatus. The valve prevents "lifting" due to falling pressures, and a by-pass from the steam space of the water chamber to the dry steam chamber prevents excessive difference in pressure during such periods. A non-return valve at the induction end of the tubular passage prevents reversal of the flow.

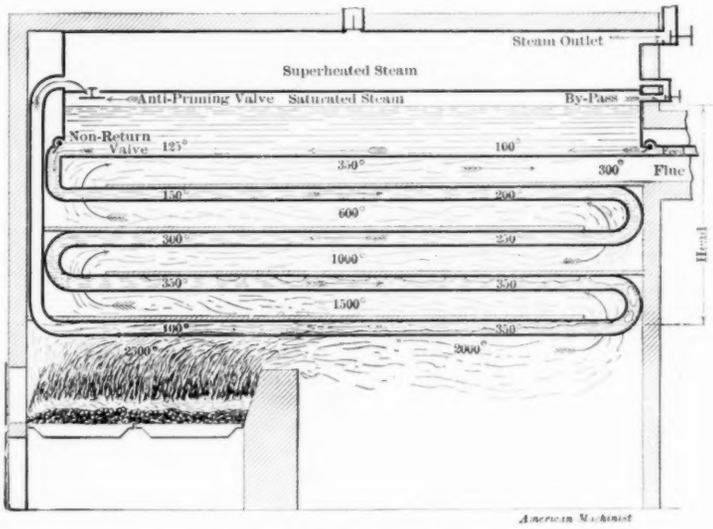

FIG. 2. EVAPORATION DIAGRAM.

In operation the water is fed into the lower chamber, whence it flows into the tubular passage and seeks its level in the upcast. When heat is applied, the water is soon driven out of the upcast by the expansion of steam. The result is a column of water against a column of steam, with a constant effort on the part of the water to regain its level in the upcast, which is frustrated by continuous evaporation.

It is a common idea that the "buoyancy" of the steam will prevent the downflow in the passage by its tendency to rise and carry the water with it. We know that gravity affects all matter, and that, theoretically, a pound of steam would fall as fast as a pound of water. That a bubble of steam rises to the top of a column of water is only true when the column is supported. The steam and the water cannot occupy the same space, and the water, being the heavier, displaces the steam and forces it to the top. A column may be part water and part steam, yet the column, considered as a whole, must obey the law of gravity and will fall unless supported. The laws of hydraulics are as true in a boiler under constant pressure as in a penstock.

The progressive increase in the temperature of the water and the corresponding decrease in the temperature of the gases are indicated by the approximate figures. The bubbles indicate the progress of evaporation, which is completed in the lower tube, and the steam reaches the upcast in a superheated state. With an ordinary boiler the temperature in the upper tube would be higher than the temperature of the gases in this case.

To secure the maximum gravity head of water would require—

a. A vertical downcast with only water in it.

b. A vertical upcast with only steam in it.

c. Complete evaporation secured in a horizontal tube connecting the lower ends of the two columns.

In the diagram the downcast is cut up into bends to give the required length of flow. The effective head will be the vertical distance from the point in the tubes where the solid column of water becomes broken by evaporation to the water level in the drum.

The rate of flow can be changed in three ways:

1. By varying the proportions of the passage and the number of bends.

2. By varying the head of water.

3. By varying the rate of combustion.

The question, then, of keeping the hot end of the tubular passage from getting too hot is merely a question of correct design, since whatever temperature a tube will withstand is no worse for it directly over the fire than near the flue.

The lifting effect upon the water, occasioned by falling pressures, affects the gravity force and acts as an instant check on the circulation or flow in any boiler. This effect is neutralized and the flow in the tubes is maintained during periods of falling pressures by the combined action of the anti-priming valve and by-pass. The valve closes at the beginning of a drop, and the by-pass allows sufficient upflow of steam to prevent excessive difference in pressure between the two chambers. The result is that the flow in the tubes is constant irrespective of changes in pressure. The tubes may be automatically flushed by closing the by-pass and causing a drop in pressure in the steam chamber.

The following points may be noted:

The water and gases flow in opposite directions, which is the ideal condition.

The flow is positive, and is most rapid in the bottom tube owing to the expansion of the water into steam.

The flow is independent of any inclination of the tubes, and is as rapid in a horizontal as in a vertical tube.

The upper tubes are always full of solid water, and there can be no water hammer action.

Evaporation is accomplished without recirculation of the water.

The steam has a short, dry passage to the steam chamber, and there is no ebullition or "boiling" action.

The separate chambers for the steam and the water eliminate the possibility of priming or foaming.

The water chamber is a perfect settling tank, owing to the entire absence of ebullition.

The pressure and the water within the apparatus can be utilized for flushing the tubes automatically.

The temperature of the heating surface is practically non-fluctuating.

It is a remarkable fact that, while it has been so often recognized that the water should flow from the flue toward the fire, it has been almost universally assumed to be impracticable without trial. Rankine states it, and so do Professor Thurston and others.

The practice with "coil" boilers, of which the Belleville is the chief exponent, is to supply the water at the hot end. When the economizers were added to the Belleville by the British Admiralty, the question was discussed of having the flow in the proper direction, but it was decided that it was too dangerous, and the flow was upward as in the boiler.

In conclusion it may be stated that it has been demonstrated by experiment that the same coil will withstand more heat with the water supplied at the cold end than at the hot end, and the reason is not far to seek. In the first case the larger portion of the coil is filled with water and the steam has a free means of escape, whereas in the

second case there can be very little water in the coil, and what there is tends to clog the escape of the steam which is mostly generated in the lower tubes and is thus compelled to traverse the entire length of the coil.

Spiral Gears—Postscript.

BY F. A. HALSEY.

"Last thoughts are best," and the following graphical construction for spiral gears having a tooth angle of 45 degrees is so much simpler than Fig. 15, published at page 1310 (1901), that I might wish the former construction suppressed, if that were possible.

In case the adjustment to suit stock cutters is to be made by changing the diameters of the gears, that adjustment can be made as in Fig. 16, which repeats, essentially, Fig. 10, which appeared at page 1285. Laying down the provisional values of the diameters at $a\,b$ and $a\,c$ and drawing $d\,e$ at the helix angle with the base line, the perpendiculars $b\,d$ and $c\,e$ to the normal helix line determine $a\,d$ and $a\,e$, the provisional lengths of the normal helixes divided by π. Changing these lengths to $a\,d'$ and $a\,e'$, such that when multiplied by the diametral pitch number of the cutter the results are whole numbers in the ratio of the required speeds, and drawing $d'\,b'$ and $e'\,c'$ gives $a\,b'$ and $a\,c'$, the corrected diameters.

If $\alpha = 45$ degrees the helix line becomes $f\,g$ and, with $b\,h$ perpendicular to it, $a\,b$ becomes equal to $a\,h$. In other words, instead of laying off the diameter lines at right angles to one another, they may, in this case, for purposes of determination, be laid off upon a straight line. This fact,

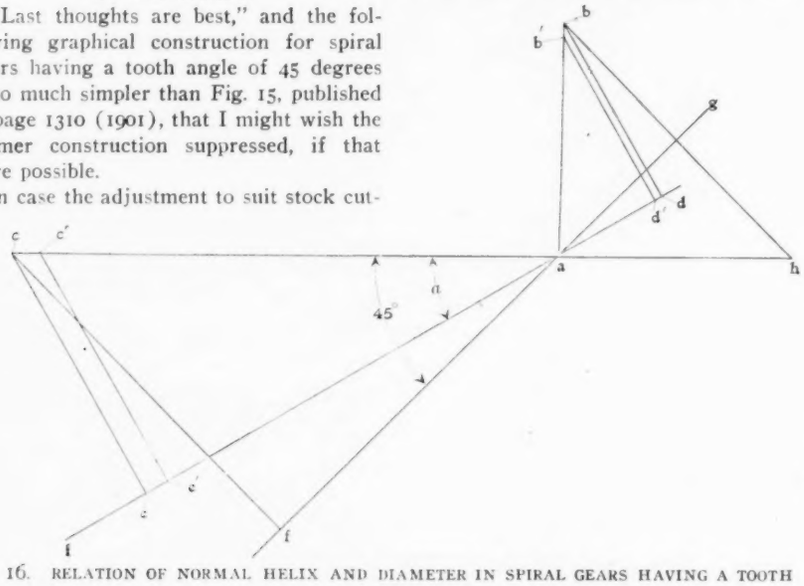

FIG. 16. RELATION OF NORMAL HELIX AND DIAMETER IN SPIRAL GEARS HAVING A TOOTH ANGLE OF 45 DEGREES.

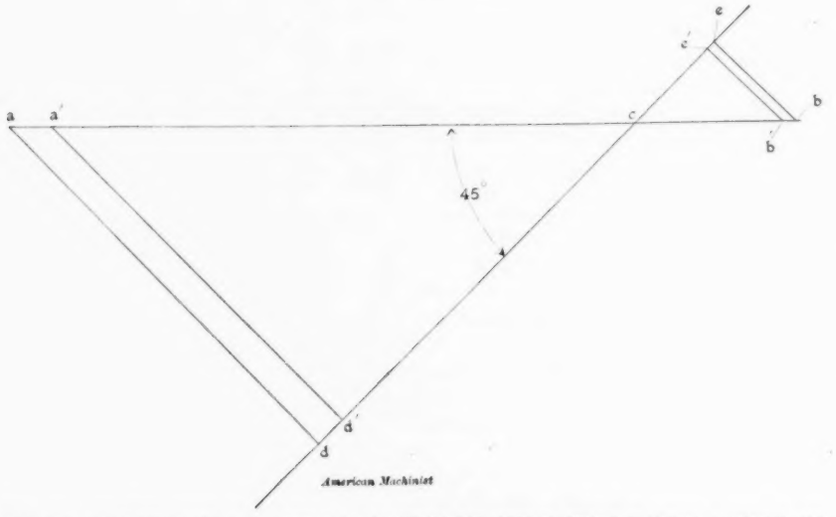

FIG. 17. SIMPLE SPECIAL GRAPHICAL SOLUTION FOR SPIRAL GEARS HAVING A TOOTH ANGLE OF 45 DEGREES.

in connection with the further fact that with a tooth angle of 45 degrees the diameters of the gears are inversely as the speeds, leads directly to the simple diagram given in Fig. 17, which is all that is required for determining graphically any pair of spiral gears having this tooth angle.

In Fig. 17 lay down $a\,b$ equal to twice the provisional center distance. Divide it at c into two parts the lengths of which are to each other in the ratio of the speeds. Draw $d\,e$ at an angle of 45 degrees with $a\,b$ and draw $a\,d$ and $b\,e$ at right angles with $d\,e$, giving $c\,d$ and $c\,e$ the provisional lengths of the normal helixes divided by π. Multiply these lengths by the diametral pitch number. If the results are not whole numbers take the nearest whole numbers having the ratio of the desired speeds, which are, respectively, the numbers of teeth in the gears. Divide these numbers by the diametral pitch numbers and lay down $c\,d'$ and $c\,e'$ equal in inches of length to the quotients. Draw $d'\,a'$ and $e'\,b'$ perpendicular to $d\,e$, and we have:

$c\,a'$ = final diameter of one gear,
$c\,b'$ = final diameter of the other gear,
$a'\,b'$ = twice the final center distance.

A Few Graphical Methods of Figuring.

BY W. S. FANNING.

Of the following methods of graphic construction, the first and second are as quick as figuring when the diameter is fractional. The third and fourth constructions will probably not give as accurate results as the first and second, as the reading of the final line will be more difficult on account of the long intersection.

The fifth construction could be done quicker by figuring, but when the result has to be laid off on paper, it is a question whether it could be done any more accurately. The sixth construction, though long, gives a means for determining a result which not every draftsman could obtain with figures. From these constructions it is seen how easily all of the most important processes of arithmetic (addition, subtraction, multiplication, division, squaring, cubing, square root) can be done.

The key to all these operations is this: If from the right angle of a right triangle a perpendicular is let fall upon the hypothenuse the perpendicular will be a mean proportional between the two segments of the hypothenuse.

I. To find the diameter of a circle which shall have a given area.

Lay off the indefinite line $a\,l$, Fig. 1. On $a\,l$ lay off $a\,b = 1$, and $b\,d =$ the given area.* On $a\,d$ describe a circle. Draw $b\,g$ perpendicular to $a\,d$. Through the intersection of this line with the circumference draw the indefinite line $a\,f$. Lay off $a\,c = 1.128$, and draw $c\,h$ perpendicular to $a\,d$. Then $c\,h$ is the diameter of the circle which has an area equal to the given area. If $a\,c$ is laid off $= 1\frac{1}{8}$, the error is only $\frac{1}{4}$ of 1 per cent. and is probably closer than anyone can measure, unless the drawing is made on a much enlarged scale. The proof of this is as follows: Let $D =$ diameter of the required circle and $a =$ the given area. Then:

$$D^2 \times .7854 = a,$$
$$D\sqrt{.7854} = \sqrt{a},$$
$$D \times .886 = \sqrt{a},$$
$$D = 1.128\sqrt{a},$$
$$1 \times D = 1.128\sqrt{a},$$
$$1 : 1.128 :: \sqrt{a} : D.$$

*The given area really equals $b\,d \times a\,b$; but since $a\,b = 1$, the area may be represented by $b\,d$. The strictly philosophical method of stating the problem would be to say: Lay off $b\,d$ with as many units of length as the given area has units of area. The same remark applies to the other problems in which areas are represented by lines.—Ed.

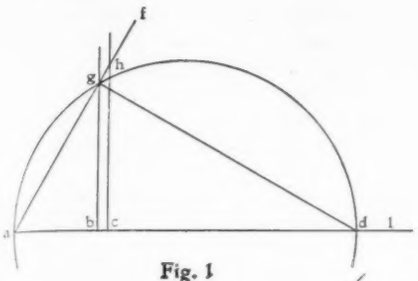

Fig. 1

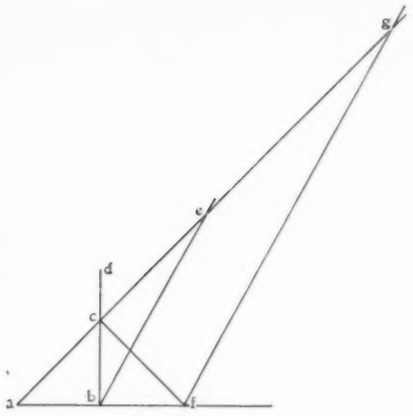

Fig. 2

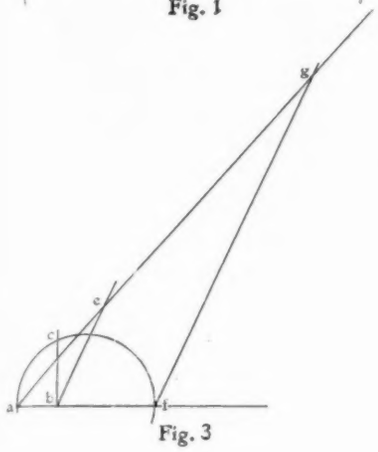

Fig. 3

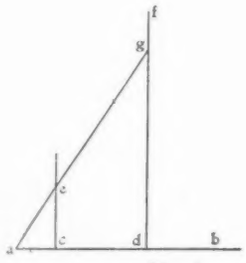

Fig. 4

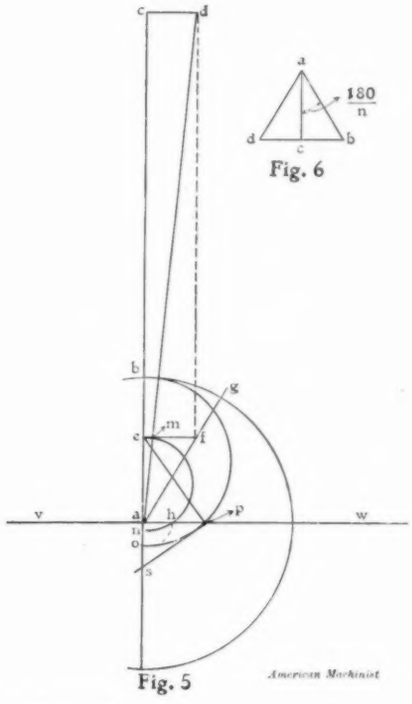

Fig. 5

Fig. 6

GRAPHICAL CALCULATIONS.

Now, $g\,b = \sqrt{a\,b \times b\,d}$, or since $a\,b = 1$ and $b\,d = a$,

$$g\,b = \sqrt{a}.$$

Also since $a\,c = 1.128$ we have by similar triangles:

$$a\,b : a\,c :: b\,g : c\,h,$$

or $$1 : 1.128 :: \sqrt{a} : D.$$

From the foregoing it is readily seen that if $b\,d$ represents the area of the circle then $c\,h$ is its diameter.

II. To find the side of a square which shall equal the area of a given circle:

Lay off on the indefinite line $a\,l$, Fig. 1, a distance $a\,c = 1.128$. At c draw $c\,h$ perpendicular to $a\,l$ and equal to the diameter of the circle. Connect a and h. Lay off $a\,b = 1$, and draw $b\,g$ perpendicular to $a\,l$. Then $b\,g$ is the side of the square required. The proof of this is the same as for the construction above, $b\,g$ being equal to the square root of area of the square which equals the side of the square.

From the above it is easily seen that if we wish to find the area of a circle of diameter $c\,h$ it is only necessary to draw from g a line perpendicular $a\,h$ to intersect $a\,l$. Then, since $b\,g = \sqrt{\text{area}}$ and $b\,d = b\,g^2$, $b\,d$ must equal the area of the circle.

III. To find the area of a circle—second solution:

Lay off the line $a\,b = 1$, Fig. 2, and draw $b\,d$ perpendicular to it. Lay off $b\,c$ equal to the radius of the circle and draw the indefinite line $a\,g$. Draw $c\,f$ perpendicular to $a\,g$ and produce $a\,b$ to meet it. Lay off $a\,e = 3.1416$. Draw $b\,e$ and $f\,g$ parallel to it until it meets $a\,g$. Then does $e\,g$ equal the area of the circle. If $a\,e$ is laid off $= 3\frac{1}{8}$ the line $e\,g$ is only $\frac{1}{2}$ of 1 per cent. too short, and if laid off $= 3\frac{8}{25}$ it is only $\frac{8}{100}$ of 1 per cent. too short. Proof: $a\,b : b\,c :: b\,c : b\,f$ or $b\,c^2 = a\,b \times b\,f$ and since $a\,b = 1$, $b\,f = b\,c^2$. If R = radius of the circle and a = the area, then $R^2 \times 3.1416 = a$, or $1 : R^2 :: 3.1416 : a$. From Fig. 2, $a\,b : b\,f :: a\,e : e\,g$, but $a\,b = 1$, $b\,f = R^2$ and $a\,e = 3.1416$, therefore $e\,g = a$.

IV. To find the diameter of a circle when the area is given (second solution):

Lay off the indefinite line $g\,a$, Fig. 3, and on it set off $g\,e$ equal to the given area. Lay off $e\,a = 3.1416$ (or $3\frac{1}{8}$ or $3\frac{8}{25}$, according to the degree of accuracy required). Draw $a\,f$ at any angle to $a\,g$, and $a\,b = 1$. Connect b and e and draw $f\,g$ parallel to $b\,e$. On $a\,f$ as a diameter, describe a circle. From b draw a perpendicular to $a\,f$ and then the distance from b to the point of intersection with the circle is the radius required. The proof of this is the same as for the preceding construction.

V. To find the circumference of a circle the radius or diameter being given:

On the indefinite line $a\,b$, Fig. 4, lay off $a\,c = 1$, and $a\,d = 3.1416$. Draw $c\,e$ perpendicular to $a\,b$ and equal to the diameter. Draw the indefinite line $f\,d$ perpendicular to $a\,b$. From a through e draw a line produced to intersect $f\,d$ in g. Then $g\,d$ is the circumference required.

If the circumference is given and the radius is required, then the operation is reversed to find $c\,e$. Proof: If D = diameter of circle and C = the circumference, then $3.1416 \times D = C$ or $1 : D :: 3.1416 : C$. From Fig. 4 we have $a\,c : c\,e :: a\,d : d\,g$, but $a\,c = 1$, $c\,e = D$, $a\,d = 3.1416$, therefore $d\,g = C$.

VI. To find the side of any regular polygon whose area shall be equal to any given area:

Draw two lines at right angles, $c\,s$ and $v\,w$, Fig. 5. Let n = number of sides in the polygon and let $b\,a = \sqrt{\text{area}}$, as found in a previous construction. With $a\,b$ as radius describe a semicircle. Divide this semicircle into n parts and let $b\,g$ be one of these parts. Let $a\,e = 1$. Draw $a\,g$ and intersect it at f by $e\,f$ perpendicular to $c\,s$. Lay off $a\,c = n$. At c lay off $c\,d$ perpendicular to $a\,c$ and equal to $e\,f$. Connect d and a. Then $e\,m = \frac{e\,f}{n}$. Lay off on $c\,s$, $a\,n = e\,m$. On $e\,n$ describe a semicircle, cutting $v\,w$ in h. Lay off $a\,o = a\,h$ on $c\,s$, and on $o\,b$ describe a semicircle, cutting $v\,w$ in p. Connect e with p and draw $s\,p$ perpendicular to $e\,p$. Twice $a\,s$ equals the length of the side required.

Proof: Let $d\,b$, Fig. 6, equal one side of the polygon $= y$. The angle subtended by the side $d\,b = \frac{360}{n}$, and the angle $c\,a\,b = \frac{180}{n}$; $\frac{c\,b}{a\,c} = \tan.\ \frac{180}{n}$, or

$$a\,c = \frac{c\,b}{\tan.\ \frac{180}{n}} = \frac{y}{2\tan.\ \frac{180}{n}}$$

Area of $d\,a\,b = a\,c \times b\,c$

$$= \frac{y}{2\tan.\ \frac{180}{n}} \times \frac{y}{2} = \frac{y^2}{4\tan.\ \frac{180}{n}}$$

and the total area $= A$ must $= \frac{n \times y^2}{4\tan.\ \frac{180}{n}}$

from which

$$y = \sqrt{\frac{4A\tan.\ \frac{180}{n}}{n}} = 2\sqrt{A}\sqrt{\frac{\tan.\ \frac{180}{n}}{n}}$$

Now in Fig. 5,

$$ef = \tan.\frac{180}{n}$$

$$em = \frac{\tan.\frac{180}{n}}{n}$$

$$ah = \sqrt{\frac{\tan.\frac{180}{n}}{n}}$$

$$ab = \sqrt{A}$$

$$ap^2 = \sqrt{A}\sqrt{\frac{\tan.\frac{180}{n}}{n}}, \quad \text{and}$$

$\sqrt{as} = ap$, or $as = ap^2$, hence $2 \times as =$ the required side.

Letters From Practical Men.

A Criticism of Some Special Fixtures.

Editor American Machinist:

Mr. Doran's article, page 1294 (1901), has been read by me with the greatest interest. It is well written, and the illustrations are beautifully clear; but I feel that for the benefit of young mechanics, and possibly others, some comment should be made upon the methods described by Mr. Doran for machining his bracket.

In the first place, let us consider what the effect of his method of setting for the first operation as arranged by him would be. For the guiding points in this operation he selects the cored holes which are afterwards to be bored out. These holes will not in the rough casting be either central with the bosses or in line with each other; but, even assuming that Mr. Doran dresses them out carefully to make them so before commencing operations, their selection as guiding points would still be wrong. Guiding points should be not those which are afterwards to be machined, but those to which it is required that the final machined parts shall have a correct relation. It is therefore obvious that the proper guiding points in his case were the outsides of the bosses.

We may now consider his second operation, that of drilling the six holes in the boss of the bracket. Why are new guiding or locating points used? Why not stick to the cored holes, or, if this was undesirable in his case, surely it would have been better to select points farther apart, where the irregularity in the surface of the casting would have been reduced instead of multiplied, as is done when the guiding points are within a less radius than the parts which are required to be located.

To have obtained good results in finishing a piece of work of this sort, the locating points should have been the outsides of the two end bearings, and from these the hole through the three bearings should have been bored. The base should afterwards have been milled, and the locating for this should have been done by placing a shaft through the bored holes. Then the drilling should have been done and the piece again located for this in the same way. By this method the locating points would have been the greatest possible distance apart, and the same points would have been used in every case.

I need hardly say that when done in this way the brackets would have been strictly interchangeable and the finished holes through the bosses would have had an equal amount of metal all around, which is necessary for both appearance and strength, while the time taken to do the work would have been certainly not greater than by Mr. Doran's way.

Mr. Doran has, in his planning of this piece of work, made two errors: first, he has chosen in both cases wrong and bad locating points for his work; second, he has, probably through an undefined feeling that the first points chosen were bad, selected others for his second operation, namely, that of drilling the base, and in doing this he has made matters worse, as his bosses after the first operation were only as true as the rough cored holes in any direction. Then by taking the sides of the base for his guiding points in the second operation, he loses control altogether of the bosses, which are the very parts which he desires to drill the holes in relation to.

To depend upon this square base having any definite and accurate relation to the bosses in such castings would be courting disappointment, as they never do and cannot possibly be expected to do so. I may therefore be excused for repeating that in such work the locating points chosen should be as far apart as possible; that they should be exterior parts with which it is desired that the finished parts shall correspond, and when once selected they or their equivalents should be used throughout the entire series of operations required to finish the piece. H. E. Brown,

Manager, The Consolidated Engineering Co., Ltd.

Slough, England.

A Decimal System for Numbering Working Drawings.

Editor American Machinist:

I have noted with interest your article on the decimal system of numbering working drawings. The most practical part of this article, to my mind, is the first paragraph of the second column on page 1427 (1901), where provision is made for numbering pieces so that they may be used for different classes of work from those for which they were first designed. This is accomplished by using "0" as the significant number when the piece may be used in several different places. The writer does not believe that it is wise or practicable, when a piece is made, to try to foresee the different uses to which it may be put, and in a place where any considerable variety of work is done nearly all drawings would be numbered 000, followed by an arbitrary number, so that the arbitrary number might as well be used by itself. If it is decided to classify solely by the character of the piece rather than by the apparatus in which used, it will be necessary to adopt a one-piece-per-sheet system of making drawings, which is often expensive and cumbersome. Besides, it is exceedingly difficult to so classify machine parts.

Your article provides a class for single pumps, another for duplex pumps, another for geared pumps, etc., but it is altogether likely that certain parts would be used in common in each of these different classes. The only object I can see in having a Dewey system of drawing numbers is to avoid the necessity of a separate index, and it would be found difficult in any works where identical parts are used in different pieces of apparatus to so classify the drawings unless one is prepared to redraw and renumber pieces already in existence, simply for the sake of maintaining the system. It is my theory that all systems should adapt themselves to production, and not production to the system, and that any method of keeping track of things which makes it necessary to increase the number of things to keep track of is wrong. The illustration adopted by your author is pump work. I have seen the drafting department of a pump works where all drawings were for years given significant numbers similar in principle to the scheme outlined, and where every drawing has since been renumbered on an arbitrary system, because of the hopeless confusion resulting from the common use of parts in many different types.

In your editorial comment you make a comparison with libraries. There is this difference between indexing books and indexing drawings: the detail drawing is rarely a commercial unit; the book always is. The details of most manufactured articles get the significant parts of their names largely from the commercial unit of which they form a part, rather than from themselves. As they form parts of different machines their names change, and so would any significant numerical designation. They are, however, drawn separately and manufactured separately, and no one in the shop, except the assembler, is particularly interested in them as parts of the complete apparatus. It is most undesirable that a given piece should be without a fixed designation, though used in different machines—hence the need of an arbitrary, rather than a significant drawing number. In libraries the Dewey system comes *after* the specific designation (the title and author), and does not take the place of it. So in the case of drawings, a Dewey *catalog* doubtless is a good thing, but significant drawing numbers are I believe, impracticable in a general manufacturing business. S. L. G. Knox.

Chief Draftsman General Electric Co.

Cutting Square Threaded Screws.

Editor American Machinist:

I should like to say a word or two about cutting square thread screws. I think

there are two or three different shaped tools that would cut such a screw, each more or less defective in the matter of top rake or side clearance. Mr. De Leeuw, at page 1160 (1901), mentions only one that will cut the thread properly, but he omits to say in what position it is to be placed, whether at, above or below the center, whether with the top parallel with the axis of the screw or inclined at right angles to the thread. My point is that the position is quite as important as the shape, and that whatever tool is used, if it is not placed in the position it was made for, the thread will not be correct. I think that when such a screw is wanted, the best way would be, first, to decide in what position the tool is to be used, make it to suit, and then see that it is placed in that position.

Leicester, England. H. H.

[Our correspondent's point regarding the position of the tool is, of course, correct, though we think that Mr. De Leeuw's drawings make clear the position intended for the tools shown.—Ed.]

"A Difficult Case—What Should be Done?"

Editor American Machinist:

The mistake made was in bringing in the outside man; for the proper, most sensible and best business policy would have been to have advanced, say, A, one of the four foremen in the conspiracy, giving him a better salary and saying to him: "We would like also to give B and C something, and we hope to some day. In the meantime we will give B more money to have him help you carry your old department along, and we trust that you will give us as valuable services in the future as you have in the past."

Results: We have in the first position the best man it would be possible to find. B's friendship is secured, C's approbation is gained, D and the engineer are interested. The entire department will be run cheaper than formerly, the output will be increased, friction will be eliminated and A and B will inevitably bring order out of chaos.

And the conspiracy? To the winds with the consipracy! A, B, C, D and the others wanted merely their just rights. Would you see them cheated out of them?

FRANK RATTEK.

Editor American Machinist:

I have read that letter on page 1432 and re-read it, and I don't know whether it is meant for a joke or not. At any rate, the faculty in question seem to have been unnecessarily alarmed. The letter states that eighty operatives were employed making metal trimmings. We will assume that the machines used are presses, drops, spinning lathes, tapping machines, screw machines, and perhaps milling machines and drill presses. Now, we will assume that the tools belong to the company and that these four foremen are obliged to leave them in the shop when they go home at night. Now, what would be the matter with the superintendent meeting these foremen at the door some fine morning and sending them all home before they had time to do any damage? If your friend understands his business, with what assistance he could get from the eighty operatives he ought to have a day's work out at six o'clock. There is not any great amount of secret about such work, and out of these eighty men we have no doubt there were four men just as intelligent, just as expert and knowing where to find the tools quite as well as the four men discharged. Then we would have the salary of the four men to distribute among the operatives as an incentive to get out the work. In my experience as a designer and maker of tools and fixtures I have to acknowledge myself more indebted to the machine operators for points picked up than to any other class. To my mind the whole problem hinges on the co-operation of the eighty men. ISAAC MORGAN.

Editor American Machinist:

I cannot agree with the conclusion reached by the foreman, superintendent and president described by "Needle," page 1432. The conditions have been presented many times to the executives of manufacturing concerns when an attempt has been made to introduce new blood. I believe that it is more often than otherwise met in the way adopted in this case, but generally because of ignorance or timidity on the part of the management.

When the new foreman found that he had the thorough backing of the management (a rather unusual feature, by the way), he should have stuck to his post and solved that problem, if it took him five years to do it. Suitable men could have been found somewhere, and they should have been introduced as ordinary workmen until used to the place and the general conditions; then when definite steps were taken to bring the sub-foremen into line, the company would not be helpless if they stuck to their conspiracy. The chances are ten to one they would have given in when they found the company meant business. They would not be the sort of men to stick together to their own hurt for a principle when they found there was no sign of yielding. Their conspiracy was born of the assurance that the management was weak-kneed and helpless, as evidenced by their openly contemptuous attitude.

Where the foreman made his mistake was in feeling that because there were no men available to help him solve the problem immediately, he must give it up. It would have been an easy thing, under the conditions outlined, to have convinced the management that it would pay them to put in six very high-grade men at foreman's wages, but to work as ordinary mechanics for a year or two, if necessary, rather than to be kept at the mercy of the cabal.

I have been up against propositions of this sort several times, sometimes in an advisory capacity and sometimes with power. The trouble has usually been started by the introduction of systematic records and checks, or of an assistant, with the intention that the company should not be left helpless in case of the defection of some man of the type described by "Needles." This has been followed by his prompt withdrawal, and of course some confusion has followed. There has not been a case (and I have at least a half a dozen in mind) where the company would have had the man back two months later at any price. When the writer has pointed out the serious objections to the continuation of conditions such as "Needles" describes he has been met by assurances of the indispensability of these men, quite as strong as in the case under discussion. But after the change, all the good methods evolved in the past being still available, and the company having the benefit of additional improvements due to new brains, together with better organization and discipline, improved efficiency has invariably resulted. Once or twice since I have been in a position of full responsibility for such moves, and where the job has been that of an "indispensable" specialist rather than a foremanship, the job itself has practically disappeared with the defection of its incumbent, and when it has come to breaking a new man into the work it has been found that there has been very little work to break him into. In one case we were told that the man in question had done the work from the time the company was started and was the only man who understood it, and that he was indispensable. He had been allowed to work independently, to make his own arrangements for overtime, help, etc. It was decided to put another man on the work with him, to avoid serious embarrassment in case of his defection. The specialist left the moment he was informed of the new arrangement, without even saying he was going. Within six weeks we were told that some other work would have to be found for the man who had been put on this job, and the work which in the hands of the experienced and indispensable specialist was costing $30 a week is now being done by a $7 boy, with time to spare. This was largely because what was being done over and over again as new work could have been equally well or better done by slight alterations in work that had been accumulating for years, but of which the specialist did not have the brains or will to avail himself. X. W. Z.

Editor American Machinist:

I am interested in the communication of "Needle," on page 1432, entitled "A Difficult Case: What Should Be Done?"

It seems to me that the new department foreman missed an excellent chance of showing his executive ability. Indeed he showed great lack of some of the qualities

which go to make up a really valuable foreman or superintendent. In accepting the situation, which he did, he undertook to promote the best interests of the company which employed and paid him, and the least he could have done when he found so serious a "conspiracy," reaching beyond his own department, would have been to report it to the superintendent and manager and to confer with them as to the best course to pursue. Instead of this, he was going to simply step out and, so far as appears, leave the company no better or wiser than when he came. It seems that his "having another good position open to him" stood in the way of his proper usefulness to the company with which he had engaged. Perhaps some of the other foremen who were threatening to leave also had good positions open to them and allowed this to stand in the way of their fidelity to their actual employers. It is perfectly right for everyone to improve his situation when he can, but "ye cannot serve two masters," and one must put forth his best efforts for his present master and in his present place, and so train himself for a better position here or elsewhere.

The most difficult factor which we see in the present case is the attitude of the president and manager of the company, who became "furious" over the affair, and was evidently acting on the impulse of the moment rather than on his sober judgment. While no concern could long prosper with such a conspiracy in its bosom, yet cool heads and cautious actions were required. Haste makes waste, and the behavior of both the president and the new foreman suggests an acute attack of stage fright.

An office consultation with "closed doors" was the right thing; but the little discussion with which "Needle" has favored us was had under most unfavorable conditions with one who considered himself an outsider and who was too easily frightened to be of any service in the existing situation. The company evidently had confidence in him and tried hard to keep him, even to offering him more salary; but he lacked confidence in himself. Parliamentary law recognizes the fact that it is difficult to discuss two questions at once and, so far as we are informed, the question of the conspiracy was a secondary one before this meeting, the leading question being whether the new foreman would stick or not.

A council of war had to be called, but the first thing to be found out should have been: "Who are for us and who are against us? Who can be depended upon to stand by the company in this its hour of need?" To this end a most cautious but thorough canvass of all the foremen and leading employees would have been in order. This canvass could best have been made by some one individual who had the necessary good nature, firmness and shrewdness to fit him for such work. Such a man could have proved himself of great value to the concern at that time, and, according to our informant, such an opportunity seemed open to his friend, but he was evidently not the man for the place.

When you tell your physician that the disease about which you are consulting him is of long standing, he will tell you that you must not expect to get well in a hurry. Now, the disease which had developed in the six prominent employees of this company had not grown to its revealed proportions in a week or a month, and it should not have been expected that it could be cured by one stroke without entailing heavy loss on the concern. Remedial measures might have been employed which, if properly worked, must have led to a better state of things.

It is evident that the superintendent and the manager had not kept in proper touch with the various foremen. A weekly or monthly meeting of all the officers, where all grievances were presented and the best means for promoting the common interest discussed, would have been a step in the right direction. Such meetings have proved the "ounce of prevention" in other cases.

I will add that the great lack of order and system found by our friend should not have been an altogether discouraging feature for him, for it showed abundant room for improvement; and if the department was keeping up with the others under the existing "chaos," how much easier could it have done so with improved methods, gradually and wisely introduced and without creating a shock anywhere.

Hackettstown, N. J. J. C. GREEN.

Editor American Machinist:

The case cited by "Needle," on page 1432, should be regarded as the usual thing rather than the exception, when the "new boss" enters the shop. It can be solved by intelligent, industrious effort. The four men mentioned were evidently too good to be discharged, for if they had been able to organize and carry through their scheme in the face of the opposition stated they certainly had ability, and ability is what is wanted in these hustling days.

"Needle's" friend should have "seen his duty and done it." He should have made his plans, given his orders and seen that they were executed; or, when this did not seem practicable, he should have executed them himself. When things were running as they should, he could then have used his discretion as to retaining or dispensing with the services of the men who were "bucking." The chances are that by that time he would have won their admiration and respect and would have found them first-class good fellows. They were looking at the thing in the wrong light, and his was the opportunity to set them right. Many a man is walking around with special knowledge under his hat which should be matter of record, and with the feeling that in so doing he is making his position more secure. When the time comes for him to make a change (and men rarely hold one job for a lifetime) he realizes with regret that his course has made him a back-number, and that his special knowledge has no market value, while had he spent his time in developing efficient systems, applicable to any similar line of business, he might have been sought by a score of concerns as a valuable man.

"Needle's" friend missed one of the opportunities of his life. He might as well have discovered a gold mine and then refused to work it because it required hard effort to get out what was in it. His was the opportunity to prove himself a leader of men, and at the same time to show that his plans were for the best interests of the company, of himself and of his subordinates, and the pathetic part of it is that he let it go by. H. C. P.

A Decimal System of Numbering Working Drawings.

Editor American Machinist:

In regard to the decimal system of indexing drawings published at page 1427, you speak editorially of its being used in two or three places and of its having been developed to cover locomotive work. About five years ago I tried to persuade a concern to use it, but the chief engineer was opposed, so it was not adopted, although a change was made to another system. About a year and a half ago I tried to get a steel mill to adopt it as a change, but, as the expense would have been considerable, the matter got side-tracked and nothing was done.

The system is entirely practicable and capable of indefinite expansion, hence its value; but it must, like all other systems, have a friend at court or it will get hopelessly mixed in short order. I have a little interest in this subject, and I am glad someone has taken it up.

A. D. WILLIAMS.

Correspondence School Instruction in Drafting.

Editor American Machinist:

I desire to notice X. Y. Z's article on correspondence schools and their instructions in drafting published at page 1405. That the average correspondence man's idea of drafting is like that of the woman teacher, or his school work, from copies, I can hardly think possible. Without a doubt original work can be shown. X. Y. Z. declares that the best of correspondence school students have little or no conception of projection. If this be true, then I must overhaul my conception of projection. I have in mind three such students who have mastered the principles of perspective, are thorough in plane and solid geometry, well along in analytics and who have carefully studied "Practical Engineering Drawing and Third Angle Projection," by F. N. Willson, with "Mechanical Drawing," by Prof. C. W. McCord, at hand.

One of the class has been a machinist

for a number of years, accustomed to a variety of grades of drawings for the construction and erection of machinery. These parties unhesitatingly declare that their study of this art dates from their enrollment in a correspondence school, and practically no instructions were received outside of these schools. These parties may not be draftsmen, but they can certainly illustrate mechanical ideas well.

That the correspondence schools can manufacture draftsmen, I doubt, but I am of the same opinion regarding other schools. I propose to credit the individual for what he is and does. Mortal clay is not so easily molded as the raw material in the potter's hands.

In this age of warranting and guaranteeing, I do not think the correspondence schools are much exceeding the present usages of these words. I can easily justify them in it, along the idea that the leading of anyone to better his condition or to increase his store of useful knowledge is a blessing.

In the preface to "Chordal's Letters" this is found: "It is not known that this proves merit . . ., but there is a pleasure in knowing that one has in the smallest way, or in any way, been instrumental in getting anybody into the habit of reading anything." A. B. C.

Considerations in the Design of Crane Girders.

Editor American Machinist:

Several articles have appeared in the "American Machinist" on the design of cranes and crane girders, and the following articles, "The Moment of Inertia of Built-Up Beams" at page 939, 1898; "System in Engineering Calculations and Records" at page 21, 1899, and "Calculations for a Crane Girder" at page 127, 1900, are very good as far as they go; but there are a few other points which a crane designer must attend to and about which nothing definite is said in the articles mentioned or in any text book that I know of.

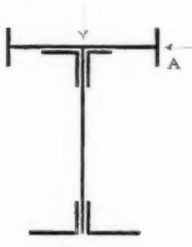

Fig. 1

Fig. 2

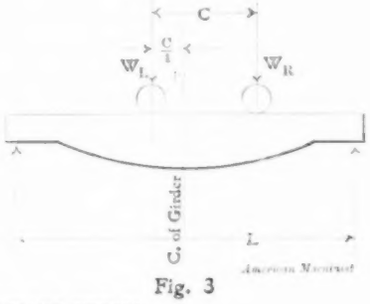

Fig. 3

POINTS IN THE DESIGN OF CRANE GIRDERS.

For instance, suppose I have a crane girder of section as shown in Fig. 1. In this case the girder is acted upon by two forces, a vertical force resulting from wheel load and a horizontal force resulting from the sudden starting and stopping at the crane bridge, the top chord acting as a strut resisting the compression due to the vertical load and as a beam resisting the horizontal thrust. Let us call the compression from the vertical load P pounds per square inch and compression at A from the horizontal thrust p pounds per square inch. Let us further suppose that the top chord, considered as a strut and figured in the usual way, is able to withstand P_L pounds per square inch. Now, the question is, is it safe to so proportion the section at the chord that $P + p = P_L$? it being borne in mind that P_L is the safe load per square inch when acting as a *strut* only, and not as a beam.

Again, suppose we have a box girder of section as shown in Fig. 2. Can we in this case rely upon the web plates to resist part of the horizontal thrust, and, if so, to what extent?

I know there are several others interested in the same subject, and we would appreciate it very much if somebody who knows would write something about it in the "American Machinst."

The formula given by Mr. Williams in "American Machinist" at page 127, 1900, for the bending moment of the girder resulting from wheel loads is convenient and probably accurate enough, especially for small cranes, but is not strictly correct. The maximum bending moment will occur when the wheels are in the position shown in Fig. 3, and when in this position the bending moment is:

$$B\,M_{max} = \frac{W}{2\,L}\left(L - \frac{C}{2}\right)^2$$

That is, the maximum $B\,M$ will not be at the center of the girder but at a distance $\frac{C}{4}$ to the left, directly under the wheel. Of course, if the trolley is moved to the left so that the wheel W_R is $\frac{C}{4}$ to the right of center line, the maximum $B\,M$ will be at that point. SAMUEL ODEGAARD.

A Standard Classification of Patterns.

A good suggestion for patternmakers, foundrymen and others seems to be embodied in the following "Standard Classification of Patterns," issued by the H. B. Olmstead Company Pattern Works, 87 Frankfort street, New York city. There is a great range of difference in pattern requirements, and unnecessary expense and delay are often incurred in making patterns with too much care and elaboration that are required only for a few or a single rough casting, or which are to be used only for a short time, with no possibility of ever being called into service again. This list suggests another list which foundrymen might adopt, having to do with the preservation of patterns and their right to prolonged existence. For instance, why should patterns of Class D ever be put in storage at all? The list is printed upon a large card intended to be hung up or kept in sight in the drafting room. It is as follows:

STANDARD CLASSIFICATION OF PATTERNS.

CLASS A.

Patterns made of hard wood or well seasoned clear pine, with leather, wood or wax fillets; to have metal rapping plates and dowel pins put in, fastened in a strong manner. Patterns to be put together with screws, nails or glue. All loose pieces to be made of hardwood. Pattern given three coats of good yellow shellac varnish. Core boxes made and finished to correspond with patterns. All core boxes and patterns to be made as instructions given by customer or mechanical engineer of the concern having the pattern made, and in such a way as to be molded in the best possible manner. Patterns to be first class in every respect. Best that can be made.

CLASS B.

Patterns and core boxes to be made of well seasoned pine, put together with screws, nails or glue and to have metal rapping plates and hardwood dowel pins put in, fastened in a strong manner. Loose pieces with sharp edges to be made of hardwood. Loose pieces in core boxes with sharp edges and small pieces to be held in place with a draw nail, to be made of hardwood, according to the best judgment of the patternmaker. Patterns to be given three coats of yellow shellac. Manner of constructing patterns to be according to instructions given by customer or mechanical engineer of the concern having the patterns made. Patterns to be made good and durable.

CLASS C.

Patterns to be made of fair stock, well put together with screws, glue or nails, care to be taken to make patterns and core boxes in such a way that they can be changed from Class C to Class B without destroying same. These patterns and core boxes would have no fillets or hardwood pieces. Two coats of red or black shellac as instructed when order is given. Patterns constructed according to our best judgment.

CLASS D.

Patterns or sweeps to be made rough, and as cheap as possible. These patterns or sweeps to be made so that one satisfactory casting may be made. Patterns or sweeps to be made according to our best judgment and not varnished.

AMERICAN MACHINIST

Published at 218 William St., New York, every Thursday by the

American Machinist Press.

[INCORPORATED.]

Also published at 34 Norfolk St., Strand, London, W. C.

Correspondence on mechanical subjects solicited. Name and address must always be given--not necessarily for publication.

Address all business communications to the American Machinist Press. Matter for reading columns may be addressed to the Editor.

Subscribers can have address changed at will. Give old and new addresses. Date on wrapper denotes end of month in which subscription expires.

Subscription Price:

$4 per year, postage prepaid, to any post office in the world. No back numbers beyond current year. For sale by newsdealers, generally.

European subscriptions served by the AMERICAN MACHINIST CO., LTD., 34 Norfolk St., Strand, London, W. C.

Entered at New York P. O. as mail matter of the second class.

Cable address, "MACHINIST," N. Y. Lieber's and A B C Codes.

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Machine Work in an Engineering College.

Among the papers read at the last meeting of the Society for the Promotion of Engineering Education was one by Professor Turner, of Purdue University, under the above title, which closely meets our own views. The paper is too long for reproduction entire, and that is really unnecessary, as it will be seen in the Transactions of the society by most of those who can profit by it. The following extracts will, however, indicate that Professor Turner is following the right course:

"Besides the first simple exercise there should be another line of work which should be the principal one. This should involve such work as the making of some machine or piece of apparatus, the making of which should be conducted according to manufacturing methods. The various parts of the chosen machine should be made by the students, special tools and jigs being provided whereby the work may be quickly and accurately done. Such a line of work gives the student a knowledge of the value of special tools and jigs, which is very desirable. Whenever special tools or jigs may be used for making a piece it is desirable that such tools be made. Much of this kind of tool and jig making can be done by the students during the latter part of the course, thus giving them an opportunity to do some fine tool-making.

"Too much attention, however, cannot be given to that part of the work which develops methods, methods which are practical and economical, which show how to make ten pieces in the time originally consumed in making one and at the same time to make each piece better and all the pieces alike. For example, consider the method of boring a shaft collar. This may be bored to exact size by the use of the forged boring tool; but who would use the forged tool when chucking reamers of the right size are at hand? It is well to teach the student the use of the forged tool, which may be used in special cases when odd sizes are to be bored or when holes are to be started to run very true, but in most cases the chucking reamers are the most desirable and the most profitable tools. Again, consider forming pieces of irregular outline. If it is lathe work, a templet may be made and each piece turned by the use of hand tools until it fits the templet; but who would use hand tools for such work when forming tools with cutting edges of the exact shape will do the work so much better and quicker? The same principle is true for such classes of work as may be done on the milling machine by the use of irregular forming cutters.

"It is the custom in some college shops to build some new style of machine each year; consequently one finds them building steam engines of various estimated horsepowers with complicated valve mechanisms; dynamos, motors, engine lathes and a variety of similar articles. Such a variety of work will not yield the best results. There are two principal objections to this method: First, the finished machine seldom equals in quality of workmanship a similar commercial machine; and, second, it is necessary in the construction of its parts to resort to methods which would not be tolerated in any well-regulated shop. When a student is obliged to resort to obsolete or primitive methods in constructing a piece because of the lack of suitable tools and appliances he is taking a step in the wrong direction. Unless the proper tools and jigs can be used it would be better to adopt the simple exercises which could be adapted to the machines and appliances at hand.

"One fact, however, must not be lost sight of, namely, that the college shop is for the purpose of teaching the student principles and methods, and is not a manufacturing establishment. There is a danger that when the manufacturing methods are adopted the desire to produce quantity will cause the educational side to be neglected. This tendency must be carefully guarded against and the educational side must constantly be kept uppermost."

The last paragraph is particularly pertinent. We do not know that its author believes in our own pet hobby—that an engineering school should select its students from shop boys, rather than from high school graduates—but what follows is entirely in line with our own often-repeated belief that the elementary exercises which comprise much of the usual school shop work are entirely beneath a course of university study. The italics are ours:

"In advocating such an advanced course of work as above indicated for the college shop it is not intended to imply that the elementary principles of machine work be neglected in order that a line of commercial work may be attempted. The first principles of machine work, involving such problems as the best shapes of tools, the methods of setting tools, methods of holding and clamping work, the best cutting speeds and feeds must be taught and instilled into the student at first. If he has not been taught these principles before entering college, then he must learn them when he begins his work, but *it would be far better if the college shop were not obliged to begin its work at the very bottom of the course. The time ought not to be far distant when the college shop may drop the work of the manual training school and take up this more advanced work which is more in keeping with the other courses of the college.* When this is done the elementary work of the high or manual training schools will be one of

the requirements for entrance to an engineering college. With such preparation the student will be enabled to begin his shop work higher in the course and thus reach a higher point than he would otherwise. He would then have a better understanding and a firmer grasp of those principles of the work which will be most beneficial to him when he enters his chosen profession."

Opinions About the National Civic Federation Meeting.

It is interesting to note the different views taken of the recent meeting of the representatives of capital and labor held in this city under the auspices of the National Civic Federation, and which we gave an account of and commented upon at pages 1413 and 1414, Vol. 24. Most of those who adhere to some panacea for the cure of industrial evils condemn it, as they always do any attempt to improve matters not in accordance with their own ideas. It seems as though some of these people would rather that industrial troubles should continue or increase than that they should be abated in any other way than the one they themselves have marked out. On the other hand, there have been a good many expressions of what seem, to put it mildly, over-confidence in regard to the outcome of the meeting. It is safe to say that very few, if any, of those who attended and took part in the meeting would claim that by what was done these labor difficulties, strikes, etc., were made virtually a thing of the past, yet in glaring headlines we are informed that is the case.

Some socialists seem to be especially bitter in their comments upon the meeting and charge hypocrisy by both classes of representatives. Samuel Gompers, president of the American Federation of Labor, who took part in the meeting, says:

"Much as absolute industrial peace may be desirable, not even the most sanguine friend or participant in this new effort entertains the belief that strikes and lockouts will be entirely eliminated from our industrial life, but that it will act for the better recognition by each of the rights to which the other may be entitled no sane or reasonable man will dispute."

A correspondent in England sends us a page advertisement from one of the cycle papers over there and which shows what purports to be a view in a bicycle factory. In this there is a row of screw machines which are the most wonderful things we have ever been permitted to gaze upon. They seem to be constructed partly of boiler plate riveted together, with seams of approved style; but the funniest thing about them is that the workmen stand behind them and work the back-tool slide from the rear, the usual levers, or such of them as are put in at the front of the machines appearing to have nobody to work them. One who had not been in England might wonder if such machines are really used there, and if it is customary for the workman to go around to the front to perform the other necessary functions in the making of a piece.

A curious and interesting phase of the labor-union question appeared recently in Meridian, Miss., according to a press report. An organizer of the American Federation of Labor came to that place and proceeded to organize workingmen. He was not interfered with until he attempted to organize the negroes, when a citizens' meeting was called, met and passed resolutions which, when handed to the organizer, caused him to desist and to announce that no further efforts would be made to organize lodges of black men.

A Pneumato-Electric Analogy.

An ingenious mechanical illustration of the laws of electricity has been described by M. Möller in a paper published in the proceedings of the Verein zur Beförderung des Gewerbfleisses and digested for the Institution of Civil Engineers, London, as follows:

"The apparatus described in this paper has been designed to assist to a clear comprehension of the relations between electromotive force, strength of current, resistance, potential, etc.

"The place of the electrical current is taken by a stream of air or any suitable gas, the motion being produced by the weight of an inverted vessel enclosing air and floating on water. A glass tube extends from the enclosed air-space downwards through the bottom of the vessel containing the water, and from here it is continued by flexible tubing through resistances, etc., and is finally led in at the top of the same vessel from which it started.

"The glass bottle containing the water with the air-holder floating on the surface constitutes an element. Two or more elements can be grouped in parallel or in series, the results corresponding exactly with the electrical phenomena. The current is measured with the aid of a small column of water moving in a slightly inclined capillary tube. The velocity of motion of this column is the measure of the current strength.

"The work done by the current is measured by having in the circuit a glass tube with a vertical step, through which the above mentioned column of water is forced. The pressure due to the weight of a column of water of a hight equal to the rise of the step in the tube is a measure of the 'counter electromotive force.'

"The voltmeter consists of a barometer tube with equal legs, one of which is open to atmospheric pressure, and the other connected with the circuit. The tube is half filled with water, the difference of level in the two legs being a measure of the 'voltage.' The resistances are constituted by bent tubes filled with dry sand.

"The author describes a number of experiments with various arrangements of the different apparatus, each designed to illustrate a particular electrical phenomenon or law."

Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer by mail.

(1) E. F. S., Lockport, N. Y., asks: How can scrap sheet iron be melted? What proportion of cast iron will it be necessary to use to make it fluid? A.—Castings made from scrap sheet iron would be good only for sash weights or for foundation pieces for columns. To prevent the oxidation and consequent loss of a large portion of the scrap it should be pounded into a conical recess to make it into balls. The balls might be dipped into a mixture of lime and sand that would run into and fill all the cavities, or the balls could be dipped into a hot solution of silicate of soda. It will take more coke to melt this than to melt cast iron. To make it fluid, add silicon pig iron. Start with 10 per cent. and increase or decrease as necessary. The more pig iron the more fluid. Ordinary pig iron (that is with less silicon) can be added, but more must be used. If you can afford it, you can use just enough silicon iron to make it run from the cupola and place in the ladle before tapping one-quarter of one per cent. of aluminum. Old tinned sheet scrap, pressed into balls, can be melted and run into sash weights without any addition.

(2) "Reader," Montreal, asks for an explanation of the effect of varying the initial temperature on the indicator card from an air compressor cylinder as well as the effect on the volume of air compressed. A.—Assuming the compression curve to be adiabatic—as it practically is—a variation in the initial temperature will produce no change in the indicator diagram, but it will produce a change in the available volume of air delivered. This apparently paradoxical statement is due to the expansion of air by heat, whereby a given quantity or weight is made to occupy a greater volume. An increase in the initial temperature causes a corresponding increase in the final temperature. Before use the air must cool to the surrounding temperature, and in doing so its volume will be lessened from what it was at delivery from the compressor. Obviously this shrinkage in volume will be less as the temperature at delivery is lower. Since the delivery temperature depends upon the initial temperature, it follows that *after the compressed air has cooled down,* its volume will be greater as the initial temperature is lower. The gain in volume from this cause is approximately 1 per cent. for each five degrees of difference in

the initial temperature. In our issue No. 9 for 1898 you will find a full explanation of the method of obtaining the adiabatic curve by calculation, with convenient short cuts, and in issues Nos. 22 and 25 for 1900 you will find excellent graphical constructions for the same curve.

The Christmas number of "Dixie," a monthly journal published in Atlanta, Ga., and devoted to Southern industrial interests, is an attractive publication filled with illustrated articles on Southern manufacturing. One of them treats of "Some Southern Machine Shops."

A regular meeting of the Central Railway Club is to be held at the Hotel Iroquois, Buffalo, N. Y., January 10, at 2 P. M.

Examination for Hull Draftsman.

The United States Civil Service Commission, Washington, D. C., announces that on February 11 an examination will be held at various places throughout the country for the position of hull draftsman in the light-house service at $4 per day. Persons desiring to compete should at once apply either to the Commission or to the secretary of the local board of examiners for application forms 304 and 375, which should be executed and filed with the Commission by February 1.

Technical Publications.

"American Mines Annual, Comprising a Careful, Accurate and Concise Compilation of the Active Gold, Silver, Copper, Lead and Zinc Mining and Milling Companies Throughout the United States." Compiled by Geo. E. Vigouroux, LL.B. 194 6x9-inch pages. New York: Geo. E. Vigouroux & Co., 1278 Broadway. Price, $5.

This mining directory is a new enterprise which it is proposed to carry out in annual editions. It is pretty copious, notwithstanding the author admits that there are some properties with which it was found impossible to communicate and which are consequently omitted. The information given in each case consists of the name of the mine, mill or company with its location or office address and sometimes the capitalization, names of officers, capacity, etc.

"Die Werkzeugmaschinen." By Hermann Fischer, Geh. Reg.-Rath u. Prof. a. d. kgl. Techn. Hochschule zu Hannover. Vol. II. Die Holzbearbeitungs-Maschinen. 236 pp. 7½x10½ inches. 421 ills. Berlin: Verlag von Julius Springer. Price, 15 marks.

At page 360, volume for 1900, we noticed the appearance of the first volume of this monumental work on machine tools, which is probably equaled in extent combined with profundity by no other in any language. This new volume treats of wood-working machinery. The author has handled the subject fundamentally, investigating the cutting action of edge tools, the forms of elementary parts of wood-working machines, etc., with great thoroughness and in a manner which ought to render his book of much value to the designer. The illustrations are in great part reproductions of line drawings, involving patient labor if they were specially prepared for this publication. A number of typical wood working machines of American, as well as German construction, are considered in the course of the volume, but it is far removed from being an encyclopedia of commercial articles. We think that the builder or designer of wood-working machinery who procures and studies it will gain a material advantage over his competitor, who, because of the difficulty of the language, or otherwise, chooses to ignore it.

Personal.

A reader wishes the address of Arthur T. Page, who, in 1892, was a resident of Minneapolis, Minn.

I. J. Merrill has left the mechanical department of the McCormick Harvesting Machine Company, Chicago, to accept the superintendency of the Keystone Manufacturing Company, Sterling, Ill.

C. E. Watterson has assumed charge of the machinery department of the E. A. Kinsey Company, Cincinnati, Ohio, succeeding R. M. Windholz, who has resigned to become vice-president of the Speed-Changing Pulley Company, Indianapolis, Ind.

William H. Purcell has resigned as general superintendent of the Morgan Engineering Company, Alliance, Ohio, to accept a similar position with the Alliance Machine Company, just incorporated by Cleveland capitalists. Mr. Purcell is succeeded by J. H. Lloyd.

Obituary.

Joseph P. Hunter, of the firm of Gwynn & Hunter, machinists, Baltimore, Md., died in Denver on Christmas Day, forty years old.

Christian Lehman died in Philadelphia the week before Christmas, seventy-three years old. Mr. Lehman was a native of Baden, Germany, and coming to this country a young man he at once engaged in the manufacture of knitting machinery in which many improvements of his invention were embodied.

Henry E. Darby, president of the Adams Laundry Machinery Company, Troy, N. Y., and superintendent of the Troy Stamping Works, died December 30, fifty-two years old. Mr. Darby was born in Troy and worked first for the Burden Iron Company, learning the machinist's trade later. He had been superintendent of the Bessemer Steel Works at Troy and was for a time associated with Tom L. Johnson at Johnstown, Pa., and also at Lorain, Ohio.

Charles Eastwood, an inventor of improvements in textile machinery, died at Manayunk, Pa., January 2, eighty-five years old. Mr. Eastwood was born near Huddersfield, England, and is said to have been the first man to introduce power looms at Huddersfield, incurring the wrath of the hand loom weavers. His most important invention was a stop motion by which looms in operation cease running when a thread breaks. He came to this country only about twenty years ago.

Commercial Review.

NEW YORK, Monday, January 6.

THE MACHINERY MARKET.

Conversations with representative sellers of both machine tools and steam engines since New Year's tend to obscure the fact that there has been any New Year's or other demarcation of times and seasons in trade. The irresistible rush of industry sweeps aside remembrance of anything but the business in hand or in prospect. In one of the steam-engine offices it was reported that orders are being turned down because of lack of capacity to supply them. One of the largest engineering and engine selling firms gives a preliminary estimate of its business for 1901 as nearly 50 per cent. above that of the preceding year in volume, the concern having been by no means slack in the earlier year. It is much more profitable to sell engines nowadays than it was during the excitement of 1899, we are informed; in fact, there was sometimes no profit in the orders booked that season, because although prices of engines had risen sharply the advances in raw materials were still greater. Engine quotations are now a little easier than they were two years ago, but the iron market has fallen much more and builders of machinery must now be accumulating a large surplus. That such is the case is evidenced in the liberality of expenditures for enlargement of their works. The Hooven, Owens & Rentschler Company, Hamilton, Ohio, as a late instance, is making improvements which will cost some $400,000. The Stillwell-Bierce & Smith-Vaile Company, Cincinnati, Ohio, is to erect new buildings in which, it is said, the company's three plants will be concentrated. The Berlin Machine Works, of Beloit, Wis.—one of the large wood-working machinery manufacturing concerns which did not enter the consolidation a few years ago—is planning extensions which may embrace five new buildings.

A contract has just been let for the construction of a 750 and a 400 horse-power Parsons (Westinghouse build) steam turbine, with Westinghouse generators for the B. F. Goodrich Company, Akron, Ohio. The machines will be used for electrical power purposes.

The organization of the Chicago Pneumatic Tool Company of New Jersey has been completed, and on December 31, 1901, took over the properties proposed, namely, the business and plants of the Chicago Pneumatic Tool Company of Illinois, the Boyer Machine Company of Detroit, Mich.; the Chisholm & Moore Crane Company of Cleveland, Ohio; the Franklin Air Compressor Company of Franklin, Pa., and the New Taite-Howard Pneumatic Tool Company, Ltd., of London, England. The securities issued are $2,000,000 five per cent. twenty-year gold bonds and $5,000,000 of common stock, there being only one kind of stock. There remains in the treasury, unissued, $500,000 of bonds and $2,500,000 of stock. The company starts with a working capital very largely in excess of a million dollars, of which more than 50 per cent. is in cash. The earnings by the constituent companies before the organization have been at the rate of $700,000 per year, which, after paying fixed charges and sinking fund under the mortgage, leaves 11 per cent. earnings on the stock. The directorate of the company includes two active officials of the United States Steel Corporation—Charles M. Schwab and his assistant, William B. Dickson. The executive committee of the new company is as follows: J. W. Duntley, chairman; Charles M. Schwab, Max Pam. The officers are: J. W. Duntley, president; W. O. Duntley, vice-president; Edward Y. Moore, second vice-president; Ernest P. Wenger, treasurer; H. R. Kent, assistant treasurer; LeRoy Beardsley, secretary; S. G. Allen, assistant secretary; Joseph Boyer, mechanical engineer; A. J. Doughty, general superintendent; Pam, Calhoun & Glennon, general counsel.

In the year 1895, if the present writer's memory serves him right, gossip was current about a possible merger of the General Electric and Westinghouse companies. The story was a hoary-headed one at that time. It is yet hale and hearty and is doing as good service as the perennial matter found in the comic papers. In the last few days the tale has been retold. It is hard to see how either company would be benefited by the merger if it should take place. Both are already so large and well organized that little economy of system could apparently be gained by consolidation. Five years ago they pooled their patents, so that the damaging litigation between them, which once existed, exists no longer. It is instructive to recall the history of the former Walker company. This concern a few years ago was a small competitor of the two principal companies in the line of alternating current machinery, but it throve and increased so that before long it was put out of the way of further mischief by absorption in the Westinghouse company. Contemporaneous comment pointed out that the success of the Walker company in securing good contracts was partly due to sympathetic or sentimental causes, *i. e.*, a disposition to encourage the small competitor, just as the Westinghouse company was encouraged in the days when it was notably weak in comparison with the General Electric Company. If the two concerns which now virtually divide the field should openly unite their business, it would form a great inducement to competition from a new factor (indeed the Bullock company is even now disposed to assert itself in large work) which might secure a good deal of trade that would have gone either to the General Electric or to the Westinghouse company had it not been for their merger.

The Navy Department continues to limit its open purchases in the machine-tool line to requirements of the Pacific Coast, some new specifications for which are mentioned herewith. It is not unreasonable to suppose that if Secretary Long retires, orders for current operations will be given out in the Navy Department more freely than of late. Despite the present Secretary's advocacy of great outlay in enlarging the navy, his administration has been marked by rigid economy in detail expenditures—such as office expenses—and the chances are that another incumbent would allow a spirit of greater laxity in buying supplies to spread through the various bureaus of the department.

Bids will be opened, January 14, for furnishing the following machines, among other articles required by the Bureau of Supplies and Accounts for the Mare Island Naval Station: Reversible steam winch, 36-inch single punch and shear, 16-inch quick-acting punch, universal splitting shears, horizontal combined punching and shearing machine, 2-inch water press, 1½-inch bolt heading machine, 50-inch vertical drill press, 24-inch vertical drill press, 6-inch full universal radial drill, radial counter-sinking wall drill, universal cutter and tool grinder.

The Census Bureau has recently made reports upon its manufacturing statistics for the States of Indiana and Mississippi for 1900, showing the increase during the previous decade. The manufacturing industries of Indiana have a capital of $234,481,528, an increase of 78 per cent. over 1890, and value of products, $378,238,100, an increase of almost 67 per cent. The State has 18,015 manufacturing establishments, 155,056 wage earners, getting an aggregate of $66,847,317 in wages. The manufacturing and mechanical industries of Mississippi show a capital of $35,807,419 in the 4,772 establishments reporting. While the capital invested increased over 140 per cent., the population during the same period increased almost 156 per cent. Manufacture of lumber and timber products is the chief industry. It employs almost 37 per cent. of all wage earners in the State, and has nearly 39 per cent. of the total value of products.

FOREIGN NOTES.

A betterment of business tone is at last manifest in the German Empire. It appears that the worst is over and people are now looking for a gradual improvement. One of the symptoms of the more buoyant feeling is an advance in the stock of one of the leading machine-tool manufacturing concerns. The better business sentiment is not an individual opinion, but is sustained by a concurrence of testimony.

In spite of the somewhat unsatisfactory state of general business in Japan, there is a most excellent outlook for the sale of machine tools there in the near future. A. M. Fisher, who has lately returned from that country and assumed charge of the machine-tool export department opened in New York by Browne & Frothingham, states that the government and other work in Japan in prospect for this year will call for probably 600 to 800 machine tools, 400 to 500 being required within his own knowledge. Mr. Fisher believes that the greater part of these tools will be bought of American builders. When asked whether the Japanese were sufficiently critical of quality to be willing to pay the prices charged for American machines in competition with the cheaper German ones, he replied in the affirmative, provided due pains are taken to explain the superiority to the purchaser. Speaking of the financial condition of Japan, Mr. Fisher said that the Chinese indemnity might be expected to help the country somewhat, but that legislative changes would be requisite to bring about a generally satisfactory state of affairs.

The American Exposition that is to be held next spring in the Crystal Palace, London, is receiving fairly good encouragement from firms manufacturing or interested in American mechanical products, to judge from the names already announced as having concluded arrangements to exhibit. The following are a few appearing in the list: Niles-Bement-Pond Company, Niles Tool Works Company, General Electric Company, Charles Churchill & Co., Ltd.; Babcock & Wilcox Ltd.; Fairbanks Company, Wellman-Seaver Engineering Company, National Cash Register Company, The Remington, and about a dozen other American typewriter companies; American Waltham Watch Company, T. W. & C. B. Sheridan, American printing and binding machinery. It is said that there will evidently be no difficulty in filling up the entire available area.

HOW AMERICAN TRADE LOOKS IN RUSSIA.

Thomas Smith, of Moscow, an importer of American machinery, has written to G. P. Altenberg, of the J. A. Fay & Egan Company, Cincinnati, a letter on trade conditions for American machinery in Russia. He refers pointedly to the effect of the late tariff troubles. In part the letter is as follows:

"Every day the government is getting

stricter about purchasing anything of foreign manufacture. You would be astonished how strict it is getting to be in all government works. Last summer I took an order for a lot of machinery to go into a government works in Siberia, among which were some of your machines. The other day my agent was down there and the director told him that they were to give another order in the spring for exactly the same outfit, only everything was to be of Russian manufacture. On account of the government acting that way it means that people must arrange to manufacture in this country, and you would be surprised how they are commencing to copy English, German and American models of every kind of machinery. The only thing as yet that I have not heard of anybody copying is your woodworking machinery, but I suppose they will soon commence, for the orders are accumulating in large quantities for your class of machinery.

"The government now demands to see every machine it buys in process of making at the works, which they generally do when several tools are ordered. I am thinking of trying to secure an agency of Russian works for mechanical tools, otherwise lots of orders I have now will be lost to me in the future. The tariff business, of course, has done a lot of harm. I see Mr. Egan is going to be among the party at Washington in this tariff business.

"I wrote Secretary Hitchcock a long letter on the tariff question, only, of course, this was private to him, giving him my ideas how the tariff has done harm to the American trade here. I only wish some American would come over with money and start making labor-saving machinery on the Yankee system. They would coin money fast, and then the Americans would see how they are respected and liked here, and what a show they would have. Cannot you get some capital to come out here? There is plenty of good, skilled Russian labor, and cheap. The Westinghouse Company has its works for electric and air-brake business, but hopes to soon take up machine tools. There is an American company starting near Moscow manufacturing railway couplings, etc. The Singer Machine Company is laying out a plant there to build sewing machines, and so are Babcock & Wilcox to manufacture boilers. These works are going to employ 6,000 men.

"In St. Petersburg they are going to build a house on the American style, all glass front, on the Newski, opposite the Kazan Church, and the Westinghouse company is going to lay out a lot of money in a new plant at St. Petersburg. The Germans are filling the Russian market with machinery, exact copies of American machinery, such as lathes, planers, drilling machines, etc., and you will be astonished how nicely they copy. I think the German will soon be in the soup with Russia on account of the duty they intend putting on the Russian grain, so you see now is the time for the Americans to come and build up. I hardly think Americans will ever have half the same trade they had before this tariff question cropped up, for the strict restrictions have all cropped up since that question was put to the front.

"The Manchurian Railway will bring a lot of money here in the near future. Next summer the Siberian Railway will be very nearly completed. It would be in good condition now had it not been for the war in China. The crops in some of the best harvesting districts have not been good, but all that does not hurt Russia, for she has an ample amount of grain in the country, and it only requires to be transported from one place to another. They have taken steps about this matter this year in time, so there will not be much trouble."

OPENINGS FOR AMERICAN GOODS ABROAD.

Textile Machinery for Mexico.—Makers of textile machinery would do well to investigate the prospects of improving their trade in Mexico. The manufacture of wool began at Tulancingo some ten years ago. There are now nine spinning and weaving mills; many of these make a specialty of woolen counterpanes and rugs, which are sold in Mexico as European articles, and also of thick, gaudy-colored woolen stuffs called "zarapa," used by the Indians. The looms are driven by steam, and are of improved English and American types. The boilers are heated by means of wood or coal. English coal costs 42 piastres per ton. A proposal is under discussion to employ electricity as motive power, to be transmitted from a central station. For making "zarapa" home-made hand looms are generally used, but the industry is so prosperous that several firms have now ordered new machinery, so that the present time is very opportune for American exporters to look after some of the business that is on hand. La Compania Industrial de Gudalajara has two weaving sheds for cotton piece goods, the "Atemajac" and "Experiencia," the former having 164 and the latter 180 looms, all of which were seat from Britain. These looms are driven by water power, which in the case of "La Experiencia" is transmitted electrically from a distance of over one mile. The dynamos are driven by a Pelton wheel, which receives the pressure of a column of water 142 meters high.

Poland.—Poland is another market in which orders might probably be obtained. The wool and cotton spinning mills of that country and Lithuania offer a very good outlet for small calendering machines costing from 27,000 to 28,000 marks.

Electric Machinery, Sweden.—Sweden is a quiet little country and we do not hear much about it, but there is a remunerative trade coming along in that part of the world. It is believed by experts that the importation of electric machines of all kinds will shortly become of great importance, as the Swedes now recognize the value of their numerous waterfalls. At present it is proposed to put down electric appartus at Trollhattan, electric tramways at Gothenburg, Lund, Bjerrod and Jonkoping. The Germans are watching the progress of this industry very closely and are sending out to Sweden experts to prepare plans.

Peat Fuel Machinery for Russia.—Great attention is now being devoted to the question of peat as fuel, and there is a good opportunity for the introduction of special machinery to utilize the immense tracts of peat land extending all over Russia. Indeed, the question is being taken up by the government and commissions have reported making important suggestions as to the manner of handling the matter and the adoption of certain machinery for the industry.

Mining Plant for South Africa.—There is now a large demand for boiler tubes and wire ropes for the Witwatersrand mines. The sizes of boiler tubes most in demand are as follows: Lengths, 8¼, 10, 12, 14 and 16 feet; diameters, 3⅛, 3½; 3½, 4 and 4. 4 inches. The latter dimensions are those most in demand. In wire ropes the sizes most current are lengths of 2,000, 2,500, 3,000 feet and more, with a diameter of 1⅛ inches, which is most in use.

Machinery for the French West Indies.—In spite of the tariff in favor of France, American machinery can compete very well in the French West Indies, one reason being the lower freight rates from the United States and another the cheapness of American machinery. There is a good trade to be had, but when trying after business always send full details—weight, size and cost of each separate part, discounts, etc. There is a demand for boilers, engines, evaporators, centrifugals, etc., for the complete installation of a sugar mill to grind cane and make about 500 tons of centrifugal sugar per season. There are also wanted several small crushing mills for grinding cane, worked by animal power. Also machinery and installations of small sugar mills to be used with the above. I do not think any firm interested could do better than place themselves in communication with the United States Consul at Guadeloupe for local details.

F. C. C.

CHICAGO MACHINERY MARKET.

An increasing percentage of the electrical machinery trade consists of orders supplementary to equipments previously installed. The orders are often small in themselves, but with some manufacturing plants are frequent—so frequent that a month never goes past without the purchase of a number of motors. The packers are typical buyers of that kind, adding constantly to their previous installations. They are also ordering entirely new equipments. Thus the Fowler & Sons Company, Kansas City, has purchased and will

soon install in that city a 300 horse-power generator with motors corresponding. It is said that the projected $1,000,000 plant which Armour & Co. were arranging to build at Fort Worth, Tex., has been shelved, at least temporarily, because of the law in that State which would subject the company to a taxation, not upon the $1,000,000 valuation of the plant, but upon $12,000,000, the entire capital of the company in all States. The St. Louis Portland Cement Company, which will have a capacity of 3,000 barrels of cement per day, will equip its plant with steam power to the extent of 2,000 horse-power, but has bought a 500 horse-power electrical generator and corresponding horse-power in motors for the operation of certain machinery that requires delicate regulation. Printers continue numerous buyers of motors. A new Chicago printing plant—that of the C. O. Owen Company—will be equipped with twenty-two Crocker-Wheeler motors. The Chicago representative of a Western electrical machinery maker has closed during the past three or four weeks four contracts aggregating 271 motors.

The view of the electrical machinery trade during the first week of January runs more largely to prospective than actual business. December is variously tabulated by sales agents. Some report the brisk trade of the past year well maintained to the end; others say their aggregate business for the month did not exceed the usual amount for December, or about half of that for November. Much of the business consisted of small orders, few notable deals having been closed. But all factors to the trade anticipate lively conditions as soon as the new year advances a little farther. They base this upon the large number of inquiries now pending, and which may be closed within a few weeks. One application, novel in the West though tried elsewhere, is for quarry work. Some plans are being prepared which, it is claimed, will when put in operation double the net profits of the quarrymen. Machine shops and factories of wide variety are negotiating for the installation of electrical power.

The opinion of several electrical men here interviewed is that the notable development of electrical railway lines this year will not be checked by the temporary difficulties of the Everett-Moore syndicate at Cleveland.

Quotations.

NEW YORK, Monday, Jan. 6.

Pennsylvania Foundry Pig Iron, Jersey City delivery:

No. 1 X	$16 65 @ $17 15
No. 2 X	16 15 @ 16 65
No. 2 plain	15 65 @ 16 15
Gray forge	15 00 @ 15 25

Alabama Pig, New York delivery:

No. 1 foundry, or soft	15 75 @ 16 50
No. 2 foundry, or soft	15 25 @ 15 75
No. 3 foundry	14 75 @ 15 25
Foundry forge, or No. 4	14 25 @ 14 75

With the exception of one important company, the maximum figures above quoted on Alabama irons are said to be the ruling price. Prompt shipments of pig iron command an indefinite premium.

Bar Iron—Base sizes—Refined brands, mill price on dock, 1.68c. in carload lots. From store, the price has stiffened somewhat, there being a more or less prevalent disposition to ask 1.95c. as a minimum.

Tool Steel—Base sizes—Good standard quality, 7c.; extra grades, 10c. and upward.

Machinery Steel — Base sizes — 1.95 @ 2.00c. from store.

Cold Rolled Steel Shafting—Base sizes —From store, 2¼ @ 2½c.

Copper—Lake ingot nominally 12⅛c.; electrolytic, 12c.; casting, 11½c.

Pig Tin—In 5- and 10-ton lots f. o. b., New York, 22¾ @ 23¼c.

Pig Lead—For wholesale lots, 4c., with .02½ @ .05c. extra for carloads.

Spelter—4.30 @ 4.35c. for ordinary quality, New York delivery.

Antimony—Cookson's, 10¼ @ 10½c.; Hallett's and U. S., 8¼ @ 8⅜c.; Italian, 7¾ @ 8c.

Lard Oil—Prime City, 81 @ 83c. in wholesale lots.

Following the decline in copper, leading brass manufacturers have reduced sheets from a 21 to an 18 cent basis.

New Corporations.

Equitable Furnace Co., of New York city; capital, $50,000.

George W. Stafford Co., of New York; object, dealing in textile machinery; capital, $300,000.

Century Envelope Sealing Co., of New York city; object, manufacturing envelope sealing and stamping machinery; capital, $120,000.

Bourne Co., with $100,000 capital. Its agent is L. B. Miller, general superintendent of the Singer Manufacturing Co., of Elizabethport, N. J.

New Catalogs.

The Uniform Steel Company, Newark, N. J., publishes a booklet (3½x6 inches, standard size) telling "What We Do."

The Sprague Electric Company, 527 West Thirty-fourth street, New York, has gotten out a new pamphlet (7x9¼ inches) devoted to direct-current generators of the split-pole type.

The Diescher Coupling Company, Pittsburgh, Pa., publishes a booklet (3¼x5½ inches) briefly treating of its shaft coupling, concerning which—"The harder the pull the tighter the grip."

The Walker Tool Company, 310 South Pierce street, Milwaukee, Wis., has sent us a little pamphlet (3½x6 inches, standard size) showing its attachable caliper points adapted to use on rods, calipers, dividers, trammels, etc.

The Quincy Engine Works, Quincy, Ill., have published a catalog of Williams vertical and horizontal engines. The pamphlet is plain and neat, consisting chiefly of tabulated dimensions and data. Size, standard, 9x6 inches.

There have come to hand two of the more recent catalogs of Watson-Stillman Company, 204 East Forty-third street, New York. One treats of tube expanders and the other of hydraulic valves and fittings. Each is 6x9 inches, standard size.

The Universal Machine Company, Providence, R. I., has sent us a catalog of universal, plain and special grinding machinery. In it we note section drawings showing the company's wheel head spindle and the pump and water connections. Size of page, standard, 6x9 inches.

The Pierce-Crouch Engine Company, New Brighton, Pa., has published a new catalog of gas and gasoline engines, "Built for Business." It is a handsome publication filled with descriptive matter and illustrations of the engines and their details. Size of page, standard, 9x6 inches.

The American Valve Company, Coxsackie, N. Y., has published an advance pocket catalog and price list of brass and iron gate valves. This is a line of valves which has been designed with special pains to produce a perfect closing action. The booklet is 3½x6 inches, standard size.

We have received from Geo. H. Johnston, Box 13, Sparrow's Point, Md., a little pamphlet relating to gas and gasoline engine or hydro-carbon motor castings, which are furnished for all parts, with materials and detailed blueprint working drawings. The pamphlet is 3⅝x5¾ inches.

The C. W. Hunt Company, West New Brighton, Staten Island, N. Y., has sent out pamphlet No. 0115, devoted to electric hoists. It is 6½x9¼ inches. Another pamphlet of the company—No. 0111—of the same size, shows how coal is handled from ship to furnace at the Lincoln power station of the Boston Elevated Railway.

The Jones & Lamson Machine Co., Springfield, Vt., publishes an attractive pamphlet in elucidation of the Hartness Flat Turret Lathe. The book consists of illustrations of the machine and its details, specimens of work done, long lists of users and plentiful descriptive matter, including directions for setting up and operating. The frontispiece shows the development of the machine from the year 1855. This pamphlet is 9x6 inches, standard size.

The F. E. Reed Company, Worcester, Mass., has published a 1902 catalog of machine tools. Besides a presentation of the company's well-known line of standard engine and foot-power lathes, the catalog shows a stud and bolt lathe, chucking lathes, turret lathes, a gun barrel reaming machine, a new gun barrel turning lathe, a 16-inch swing forming lathe, a new rack cutter, a spindle drilling lathe, etc. The pamphlet is 9x6 inches, standard size.

The absorption by the American Can Company of a large share of the tin can and can machinery business of the country gives special importance to those builders of such machinery that are not controlled by the trust. The Fred. J. Swaine Company, St. Louis, Mo., has just brought out a new catalog of power presses, swedging machines, foot presses, double seamers, drop presses, dies and special machinery for working wire and sheet metal. It is 6x9 inches, standard size.

Manufacturers.

Waltershied Bros., Wichita, Kan., are buying more machinery for their machine plant.

The S. Flory Manufacturing Company, iron founder, of Bangor, Pa., will enlarge its plant.

A factory building is to be erected in Harrison, N. J., for the Driver-Harris Wire Company.

The Steel Car Forge Company, Pittsburgh, Pa., will add largely to the capacity of its works.

The Dempster Manufacturing Company,

windmills, Des Moines, Ia., will build a branch in Sioux City.

The Lippitt Woolen Company, Woonsocket, R. I., thinks of building a dye house and boiler and engine room.

The Champion Coated Paper Company, Hamilton, O., has suffered from a disastrous fire, but will rebuild.

A contract has been let to build for the Harrison Safety Boiler Works, Philadelphia, Pa., a machine and erecting shop.

Bids are now being taken for the shop equipment of the Fort Pitt Malleable & Gray Iron Casting Company, Pittsburgh, Pa.

Jacob Miller, Sons & Co.'s textile mill in Philadelphia, Pa., is to be greatly enlarged, including an extension to the boiler-house.

The Thorndyke Turning Company, woodworkers, Boston, Mass., are rebuilding their factory, recently burned at Baldwinsville, Mass.

The shop of the J. S. Graham Machine Company, manufacturer of wood-working machinery, Rochester, N. Y., has been badly damaged by fire.

The Atlanta, Ind., plant of the American Tin Plate Company is to be dismantled. The plant was built in 1893 and was recently enlarged.

The contract has been let for an 80x200-foot foundry addition for the Stowell Manufacturing & Foundry Company, South Milwaukee, Wis.

There is some talk of a new rolling mill being built at Dayton, O., by the Israel Bros., scrap dealers of that place. Plans will soon be drawn.

The Landis Tool Company, Waynesboro, Pa., has nearly completed a large grinder which is to be 21 feet long, weighing about 30,000 pounds.

The Michigan Steel Boat Company will remove from Kalamazoo to Detroit, where it has arranged to build a factory with main building 68x400 feet.

D. G. Enos and J. Calvin Hess, both of Philadelphia, are at the head of the Fashioned Hosiery Company, which will build a factory at Lebanon, Pa.

An ice plant is to be built at New Philadelphia, O., by parties from Cambridge, O. Chas. E. Boden, of the latter place, is one of the leading promoters.

The Bradford Steel Company, Bradford, Pa., has practically completed its plant and will soon begin the manufacture of a special grade of tool steel.

A bridge building plant is one of the proposed manufacturing establishments to be located at Wheeling, W. Va., by the Board of Trade of that place.

The Peace Dale (R. I.) Manufacturing Company is building an addition to its mill, 196x25 feet, which is intended to provide for about fifty more looms.

The large factory of the G. S. Graham Machine Company, Rochester, N. Y., was destroyed by fire a few days ago. The loss is estimated at $100,000.

The Greene Manufacturing Company, Ltd., furniture manufacturer, Greene, N. Y., has lost by fire its main factory building, with engine, machinery, etc.

Tenney & Porter, manufacturers of horn and celluloid goods, Leominster, Mass., will erect a larger factory on the site of one lately destroyed by fire.

Plans for an addition to the Weir Stove Company's plant at Taunton, Mass., have been considered, and it is expected to build the structure in the spring.

A company composed of Jas. A. Outerson, M. S. Wilder, F. P. Ball, of Carthage, N. Y., and others, is to build a paper mill costing about $175,000 at Carthage.

A canning factory at Franklinville, N. Y., of which A. O. Holmes is secretary, will equip a box factory with automatic machinery for nailing and other purposes.

Plans have been filed for a ten-story brick factory, to be built by E. W. Bliss at No. 312 to 316 East Twenty-third street, New York, on a plot 53.7x90 feet.

Wallace L. Hart, whose wood-turning shop at Bristol, Conn., was destroyed by fire recently, will rebuild. The new factory will be equipped with modern machinery.

A large steel plant is contemplated for Louisville, Ky. Mr. Parker, secretary of the Louisville Bolt Company, and several other parties are the interested persons.

It is stated that the Island Foundry Company, Mechanicsville, N. Y. (D. Powers & Sons, Lansingburgh, N. Y.), will rebuild its plant, which was destroyed by fire.

The Alpena Portland Cement Company, Alpena, Mich., is making repairs. New machines will be added, both in the addition which is being built and in the present works.

Architects Stearns & Castor, Philadelphia, Pa., are preparing plans for a plant for Thomas Davies & Co. A boiler-house, dye-house, etc., are included in the scheme.

The Ashland (Ky.) Coal & Iron Company is planning improvements and enlargements, including a new steel mill. The capital stock has been increased from $600,000 to $3,000,000.

Work will be begun early in January on the new plant of the Norwalk Iron & Steel Co., Norwalk, O. The main building will be 100x460 feet, with other buildings 40x200 feet.

It is believed that the Hope Mills Manufacturing Company, Hope Mills, N. C. (office, 333 Drexel Building, Philadelphia), will proceed to erect two new cotton mills and a finishing mill.

A new shop building, 200x200 feet, is to be erected by the Berlin Machine Works at Beloit, Wis. The company expects to erect five new shop buildings the coming year, to cost about $100,000.

Arrangements are progressing for the establishment of the plant at Ecorse, Mich., of the Detroit River Sugar Company, which will manufacture beet sugar, and also glucose from corn.

Jas. Rees & Sons Company, builder of boilers, etc., Pittsburgh, Pa., will erect a new plant near its present location, which has to be abandoned on account of its present site being sold.

Nash & Dowdle, contractors, of Chicago, have established quarters in New Orleans, La., and propose to erect a plant there for the manufacture of supplies, material and machinery.

Jackson, Ga., is to have a knitting mill, yarn and weaving mill. An application has been filed for a charter for the McCord Milling & Manufacturing Company, which will erect this mill.

Additions to the armor plate shops of the Carnegie Company, at Homestead, Pa., will be made in the early spring to double the present output. Two new open-hearth furnaces will also be erected.

The new factory for commercial stationery, to be equipped with an electric power and lighting plant, is to be built in Springfield, Mass., by the Account, Credit & Assurance Company, of New York.,

Further enlargements of the foundry plant of Stanley G. Flagg & Co., at Pottstown, Pa., are contemplated. A large tract of ground adjoining the present works has been purchased for the new plant.

The Printers' Roller & Supply Company has purchased the Elsie Roller Composition Company's plant at Indianapolis, Ind. The new company intends enlarging the place and installing new machinery.

The Wm. B. Scaife & Sons' Company, Pittsburgh, Pa., has been incorporated under the laws of New Jersey, with a capital stock of $850,000. The concern will increase its investment and extend operations.

The Rochester & Pittsburgh Coal & Iron Company will build a pig iron plant at Dubois, Pa. Eighty acres of ground have been purchased. A nail mill, foundry, machine shops and boiler works will also be built.

The stockholders of the People's Power Company, Rock Island, Ill., which supplies Rock Island and Moline with gas and electricity, have given authority for a practical doubling of the capacity of the plant.

New factories at South Port Huron, Mich., are to be erected for the Port Huron Malleable Iron Company, the Marshall-Crosby Company and the Vine & Root Manufacturing Company, manufacturer of machinery.

Boll Bros.' Manufacturing Company, maker of wire mattresses, etc., Harrisburg, Pa., is enlarging its factory, because of its rapidly growing business. Work has been commenced on a new $19,500 building.

According to a report from Niagara Falls, W. B. Rankine says that the Canadian Niagara Power Company has bought 300 acres of land near the Dufferin Islands, on which to build factories and possibly an industrial village.

The Fort Pitt Malleable & Gray Iron Casting Company, Pittsburgh, Pa., expects to have its new plant completed and ready for operation by March 1. The buildings are being put up by the Pittsburgh Construction Company.

The Dowerman Rivet & Bolt Manufacturing Company, Pittsburgh, Pa., has been organized by Wm. F. Dowerman, Wm. S. Evans and John Emmel, Jr., all of Pittsburgh. The company will erect a plant to make rivets, bolts, etc.

A $100,000 ice plant is to be built in Hazelwood, Pittsburgh, Pa. The site was bought by F. C. Kohne, of the Hazelwood Savings & Trust Company. Mr. Lytle has organized a company and a charter will be applied for at once.

A plot of 10 acres between Hempstead and Garden City, L. I., has been purchased by the Lalance & Grosjean Manufacturing Company, of Woodhaven. The company will erect a branch factory on this site for the manufacture of agate ware.

It is reported that there is to be a consolidation of the Link Manufacturing Company and the McLaughlin-Martin-Parkhurst Company, both of Canandaigua, N. Y., manufacturers of sheet metal ware. It is stated that the capacity will be enlarged.

Belding Bros. & Co., manufacturers of sewing silks, etc., New York city, have decided that the new factory just completed at Belding, Mich., is not large enough and have accepted plans for an addition, 200 feet in length and four stories high.

The Clifton Manufacturing Company, which is said to be of Hyde Park, Mass., intends to build a 200x50-foot branch plant at Buffalo, N. Y., where it will manufacture a special kind of iron and steel pipe for gas and water mains and electric wire conduits.

The National Cereal Milling Company, of New Jersey, proposes to locate a large cereal mill in Peoria, Ill. It has also recently acquired cereal mills in Chicago and St. Louis. The company will equip temporary offices at 414 Main street, Peoria.

Young & Stratton Bros., millers, Allegan, Mich., will build a new mill next spring. They will move the machinery from their present mill to it, using the old building as a power-house, placing a dynamo there and generating electric power for running the new mill.

Dilworth, Porter & Co., Ltd., manufacturers of railroad spikes, Pittsburgh, Pa., have awarded the contract for rebuilding their Southside plant that was destroyed by fire some months ago. The company has been using temporary buildings since the fire.

Work has begun on the Great Northern's new shops at St. Paul, Minn. It is unofficially stated that the machinery and boiler shops will be more than 100 feet wide and about 600 feet long and that the shop buildings and equipment will cost more than $1,000,000.

The Madisonville (O.) Woolen Mills have been incorporated with a capital stock of $50,000. About $30,000 is to be invested in a plant. The incorporators are Henry Kressel, W. A. Bickman, Henry Fisher and Edward K. Poor, of Cincinnati, and J. W. Conboy, of Madisonville.

The Bessie Minge Manufacturing Company has been organized in Demopolis, Ala., with a capital stock of $100,000, to build a cotton mill. Officers have been elected as follows: President, J. M. Minge; vice-president, W. C. Harrison; secretary and treasurer, J. C. Minge.

The directors of the Youngstown (O.) Iron Sheet & Tube Company have voted to increase the capital stock from $2,000,000 to $4,000,000. The idea is to use the additional stock in erecting an open-hearth steel furnace and enlarging the present plans of the plant.

The Anchor Engineering & Machine Company, Pittsburgh, Pa., has been reorganized to engage in the manufacture of the Anchor gas engine and general rolling mill machinery. The gas engine is the design of Alex. Backstrom, formerly with the Westinghouse interests.

Plans and specifications for a combined lighting, power and pumping station for New Ulm, Minn., are being designed by Engineer Charles L. Pillsbury, of Minneapolis. The plans contemplate the addition of two engines, two generators of 75 and 125 kilowatts capacity and a triplex pump.

The capital is subscribed for a $1,000,000 blast furnace to be built on Zug Island, in the west end of Detroit, Mich. The Detroit Southern Railway has purchased 75 acres adjoining the furnace site and will construct extensive docks for providing ore vessels with return coal cargoes at Lake Erie prices.

The Baldwin Company, Cincinnati, O., will formally take over the Baldwin Piano Company, the Ellington Piano Company, the Valley Gem Piano Company and the Hamilton Organ Company. The companies included have been owned by the same interests for some time. A new factory is under consideration.

The plant of the Marine Iron Works, Dominick street, near Southport avenue, Chicago, Ill., which was recently destroyed by fire, is to be rebuilt at once. The buildings will include a two-story machine shop, 40x110 feet; a one and two-story structure, 50x182 feet, for pipe shop and offices, and a two-story boiler-house, 62x64 feet.

A contract for several new buildings at the Southern Railway Company's shops between Tuscumbia, Ala., and Sheffield, in addition to the buildings already constructed, has been awarded to J. M. Hughes, of Beaver Dam, Pa. Mr. Hughes also has a franchise, recently granted by the City Council of Tuscumbia, for an electric light plant and waterworks.

The Cedar Rapids (Ia.) Tank & Pipe Company has been formed and proposes to build a factory. William Horn, Jr., of Keokuk, Ia., will be the manager, and associated with him will be T. C. Munger and W. C. La Tourette, of the Cedar Rapids Pump Company, and J. A. Chandler, C. H. Chandler and W. H. Dunshee, of the Chandler Pump Company.

The Pittsburgh Friction Draught Gear Company has been chartered at Harrisburg with a nominal capital of $1,000. The incorporators are William M. Orr, William D. Harbison, Allegheny, and William H. Woodcock, Canton, O. Officials of the company announce they will build a factory somewhere in or near Pittsburgh and manufacture a new device for coupling cars.

Work on a new tin plate plant which will be erected in Port Vue borough by McKeesport, Pa., capital will be started within a few weeks. The construction will be under the supervision of Edward Crawford, of Duquesne, formerly an official at the Demmler combine mills. The company has an authorized capital of $6,000,000. The plant will be independent, and will employ about 300 men at the outset.

Captain James Davidson, whose residence is understood to be Bay City, Mich., has awarded a contract to the American Construction & Supply Company, of New York, to build for him at Dresden, Ont., a sugar factory, the minimum capacity of which will be 600 tons of beets. This company is the same that is building the factory at Sebewaing, Mich., the superintendent of which factory is Emil Brysselbout.

It is stated in Louisville, Ky., that officers of the Federal Chemical Company announce that immediately after the first of the year a large plant will be erected either in Atlanta or Nashville, probably the former, for the manufacture of finished fertilizer, acid phosphate and sulphuric acid. The Federal Chemical Company comprises a number of Louisville men, including John M. Atherton, George Gaulbert, Jeff Stewart and others.

The Federal Boiler & Supply Company, has been incorporated under the laws of New Jersey with $3,500,000 capital stock. The new company will take over the Kellogg-McKay-Cameron Company, of Chicago; Kewanee (Ill.) Boiler Company and the Model Heating Company, of Philadelphia. C. V. Kellogg has been elected president; W. H. Pfahler, vice-president, and D. F. Baker, secretary and treasurer. The headquarters will be in New York.

The American Palace Car Company, of New York city, has been incorporated, with a capital of $5,000,000. George E. Bouchie subscribes for $4,995,000 of the capital. The incorporators include President J. H. Hoadley, of the International Power Company; L. W. Baldwin and W. J. Arkell, of New York. The company will manufacture a car to be used as a chair car by day and sleeper car at night, and it is said that its operations will be largely abroad.

The Norwalk Steel & Iron Company, which is to build a plant in Norwalk, O., has been chartered in Delaware with $1,000,000 capital stock. Edward E. Erickson, of Pittsburgh, engineering contractor, is general manager and chief engineer of the corporation. Mr. Erickson was expecting to move to Norwalk at once. The plans call for one main building, 400x100 feet, and auxiliary buildings for the power plant, electric lighting station and general office.

Charles P. Tonoray and George E. Boren have returned to Elizabethton, Tenn., from New York, where they closed negotiations with the Electric Furnace Company in regard to the erection of an electric steel plant at Elizabethton. It is said that by this method steel ingots can be produced directly from iron ore in thirty minutes. An 8,000 horse-power electric plant will be commenced as soon as the site can be decided upon on the Watauga River, near Elizabethton.

A new company is being formed to carry on in Utica, N. Y., the manufacture of steam and hot water radiators. A plant will be erected in East Utica. The name of the concern will be the New York Radiator Company. The gentlemen chiefly interested are Frederick T. Proctor, H. Gilbert Hart, Charles B. Rogers, president of the First National Bank, Utica, and Joseph Rudd. The business will, in fact, be conducted in conjunction with that of the Hart & Crouse Company.

The Wood & Brooks Company is a company formed to manufacture parts of musical instruments of wood, ivory, etc. Its directors are Charles H. Wood, of Deep River, Conn.; Hilton C. Brooks, of Chester, Conn., and Luther G. Allen, of Brooklyn, N. Y. Mr. Brooks is the president, and Mr. Wood the treasurer. The company has broken ground for a plant in Buffalo. Orders have been placed for the machines, which are largely of special nature, and which will be driven by motors using Niagara Falls current.

Three big paper mills are to be erected, it is said, by the Haverhill Box Board Company (capital stock, $500,000), recently organized at Haverhill, Mass. The organizers are Cornelius Fairbanks, of Terre Haute, Ind., former president of the American Strawboard Company; Mr. Williams, of New York; B. I. Harter, of Chicago, and W. S. Lowe, of Lima, O., officers and stockholders in the American Strawboard Company, of Chicago. The first plant will be built at Haverhill. Mills will be erected at Piermont, N. Y., and at Chicago.

The business of the Waltham (Mass.) Machine Works, Ellis & Sanderson, proprietors, has increased so rapidly of late that the main factory is not large enough to handle all the orders. Since October 1 a branch shop has been operated in Boston by this firm, and recently it has obtained control of the plant of the Alcorn & Ames Machine Company in Waltham, and is now carrying it on in connection with the other two shops. The firm is very busy on orders for automatic machines for watch, clock and similar factories, and for punches and dies and other fine work, and regards the outlook for the future as highly promising.

The American Bicycle Manufacturing Company, with $8,000,000 capital, and the International Motor Car Company, with $2,000,000 capital, have been incorporated under the laws of New Jersey. The directors of both companies are the same, consisting of Joseph E. Bromley, R. L. Coleman, George Pope, Theodore E. Merseles and Paul Walton. With the exception of the last named, these gentlemen are directors in the American Bicycle Company. These two concerns will, it is said, practically separate the business of the American Bicycle Company, the new bicycle concern taking over the bicycle business, while the new motor company will make and operate motors.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Gear Wheels, gear cutting. Grant; see p. 18.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Punches & dies. Wal.M.Wks.,Waltham,Mass.

Fine machine and experimental work. The Des Jardins Type Justifier Co., Hartford, Ct.

Light and fine mach'y to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Special tools, models, fine light mach'y and

foundry work wanted. Murray Mfg. Co., Richmond Valley, Staten Island, N. Y.

F. J. Stokes Machine Co., 13th and Noble sts., Philadelphia, cut light gears, cams and duplicate small machine parts, in quantities.

Practical man with $5,000, to take interest in small manufacturing company; silent or active; goods have merit and no competition. Box 44, AMERICAN MACHINIST.

Wanted—Manufacturing site; information desired regarding property suitable for large engine factory in Pennsylvania, New York or New Jersey. Address "Alpha," care AM. M.

Wanted—An interest in, or will buy outright, a metal working plant; have option on a profitable specialty that could be combined; East preferred. "Plant," care AMER. MACH.

Mechanical and electrical engineer, with large experience in design and manufacture of supply articles, desires to correspond with party having shop suitable for the manufacture of the same. X. Y. Z., care AM. MACH.

A middle-aged man, with 18 years' experience in the office and selling end of a manufacturing business, wishes to purchase an interest in and associate himself with a small manufacturing business. Box 316, AM. MACH.

Purchaser for small manufacturing plant; lot, 100x180 feet; machine shop, 32x68, two story, with line shaft and gasoline power; foundry, 40x54, new modern equipment; good location; for sale cheap. Hart-Parr Co., Madison, Wis.

Foundry in eastern Pennsylvania, making a specialty of machinery castings, would like to make contract with machinery manufacturing concern for furnishing strictly high-grade castings at lowest figure. Address "Foundry," care AMERICAN MACHINIST.

Patents, trade-marks, designs, copyrights secured in all countries at moderate charges; patent litigation conducted; personal, prompt and careful attention. Oscar A. Michel, 229 Broadway, New York. Send for Souvenir List M. Telephone 6209 Cortlandt.

A thorough machinist, with good shop located in southwestern Ohio, would like to correspond with the object of making permanent contract to build medium weight machinery; those having established trade preferred. Address Box 314, AMERICAN MACHINIST.

Institutions retiring from business having machine tools, brass and wood working machinery will find it to their interest to correspond with us. We purchase complete plants or handle them on com. C. C. Wormer Mach. Co., 55-59 Woodbridge st., W., Detroit, Mich.

The annual meeting of the stockholders of the American Machinist Press, for the election of five directors for the ensuing year and for the transaction of such other business as may properly come before the meeting, will be held at the office of the company, No. 118 William st., in the city of New York, on the 13th day of January, 1902, at 12 o'clock noon.

A. LEIGHTON DONNELL, Secretary.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded; but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents.

Situations Wanted.

Practical mechanical draftsman wishes position. Box 16, AMERICAN MACHINIST.

Competent draftsman wants position; light and fine work. Box 45, AMER. MACHINIST.

Thoroughly competent man desires position as chief engineer of power station. Box 43, AMERICAN MACHINIST.

Mechanical draftsman, experienced designer, wishes position near New York city. Box 48, AMERICAN MACHINIST.

Superintendent, experienced in manufacture of dynamos, motors, arc lamps, tools, etc., desires engagement. Box 35, AMER. MACH.

Mechanical engineer, experienced in drawing office, shop and outdoor work, is open for engagement February 1. Box 47, AM. MACH.

Draftsman, first class, practical mechanic, seeks position: American; age 25. For particulars address "Thorough," care AM. MACH.

Young man, experienced in design and construction of gas engines, desires position; technical education; good references. Address Box 37, AMERICAN MACHINIST.

A practical superintendent or general foreman of 20 years experience on high-speed and Corliss engine and mill work. Address R. J. S., care AMERICAN MACHINIST.

Position wanted as chief draftsman, assistant superintendent or manager, by competent man, 11 years' experience; machine tools preferred. Box 23, AMERICAN MACHINIST.

I make a specialty of designing and constructing small automatic machinery; experienced in working paper; open for engagement; $2,000 per annum. Box 38, AMER. MACH.

Young man, understands tool, die, model work and taking charge of men; has traveled on the continent as engineer and machinery expert; speaks French. Box 46, AM. MACH.

Superintendent desires change; first-class machinist, toolmaker and designer; good systematic and executive ability handling men and getting out work. Box 36, AMER. MACH.

Mechanical engineer and draftsman, practical man, to lay out and superintend erection foundry, steam plants and general work, open for engagement February 1. Box 20, AM. M.

Draftsman and designer, experienced in modern interchangeable work, tools and methods, with executive ability, wants change; 6 years present firm; best references. Box 42, AMERICAN MACHINIST.

Graduate of M. I. T., with 7 years' practical experience, now head draftsman cotton manufacturing and printing company, seeks responsible engineering position; refers to present employers. Box 33, AMERICAN MACHINIST.

Position by first-class man, to take charge of designing or manufacturing of light automatic machinery, envelope, paper bag, adding machines, etc.; large experience; best references. Box 34, AMERICAN MACHINIST.

Mechanical engineer, 36, married, A1 mechanic, 12 years' past practical experience, specialty designing and erecting entire plants, desires to become connected with large, responsible concern as superintendent, master mechanic, consulting or chief engineer; best of references. Address "Mechanic," care AM. M.

Position as milling machine foreman, by a technical, practical and experienced mechanic on medium size work; well up in designing jigs, cutters, devices, etc., for the rapid milling of interchangeable parts in quantities, also cam and gear cutting and modern universal milling practice in general. Address "Energetic," Box 304, AMERICAN MACHINIST.

A gentleman, who is an educated engineer with considerable experience in this country and Europe, speaking five languages, will make arrangement with parties wishing to construct "automatic" factories, equipped with modern labor-saving machinery and appliances, in England or France; with a view of taking entire charge of the design, erection and development. Address "Vulcan," care AMERICAN MACHINIST.

Help Wanted.

Machinists to sell my calipers, etc.; liberal inducements. E. G. Smith, Columbia, Pa.

Wanted—First-class toolmaker and one machinist. Address Day Mfg. Co., Lake View, N. Y., for 30 days.

Wanted—One or two good patternmakers, accustomed to heavy work. Apply "Baltimore," Box 29, AMERICAN MACHINIST.

Wanted—Die sinker on sheet-metal dies; must be a first-class workman and strictly temperate. Address P. O. Box 112, Anderson, Ind.

Wanted—Mechanical draftsman; one familiar with mining machinery; state salary expected. Address M. F. L., AMER. MACHINIST.

Wanted—First-class draftsman, on engine work; give references, experience and salary expected. The Ball & Wood Co., Elizabeth, N. J.

Wanted—By Struthers, Wells & Co., Warren, Pa., a first-class assistant foreman for boiler shop; write at once for particulars, stating experience, etc.

Wanted—Number of patternmakers, experienced on compressor or steam engine work; none others need apply. Franklin Air-Compressor Co., Franklin, Pa.

Wanted—An experienced Gisholt lathe operator, 24 in. machine; state salary expected and previous experience. Address Model Gas Engine Co., Auburn, Ind.

Turret lathe foreman wanted, with experience on Gisholt and Jones & Lamson machines, capable of getting out special tools for same. Box 31, AMERICAN MACHINIST.

Wanted—Workmen on sheet iron forming, in which ability to operate riveters, bending machines, etc., will be necessary. Address "Machinery," care AMERICAN MACHINIST.

Wanted—Draftsman, familiar with machine tools, to work on details; steady employment to right man. Apply, stating age, experience, salary expected, Box 18, AM. M.

Superintendent for brass foundry; must be first class, thoroughly experienced and capable of taking entire charge. Address, with full particulars, Box 26, AMERICAN MACHINIST.

Wanted—A first-class machine shop foreman; heavy work and large tools; about 75 men; shop 15 miles from New York. Address W. W., care AMERICAN MACHINIST, stating reference, wages, etc.

Wanted—Experienced mechanical draftsman, familiar with designing heavy machinery; applicants will state previous experience and salary expected; give age and references. Box 7, AMERICAN MACHINIST.

Wanted—A man to divide his time between erecting and selling gas engines; man who can do drafting preferred; state salary expected and previous experience in each line. Address Model Gas Engine Co., Auburn, Ind.

We are enlarging our works, and will shortly require an increased number of skilled mechanics; we invite application from pattern makers, molders and machinists. Address the Westinghouse Machine Company, East Pittsburgh, Pa.

Wanted—General foreman for sheet iron shop, in which a good working knowledge of machine methods of forming sheet iron into various shapes is necessary; good salary and permanent employment to a competent man. Address "Iron," care AMERICAN MACHINIST.

Wanted—Foreman to take charge of machine shop in western Pennsylvania, manufacturing gears and machinery; must be experienced and up to date; state salary expected; position permanent, with opportunity for advancement. Box 32, AMERICAN MACHINIST.

Wanted—Foundry foreman; machine tool and light work; employing about 40 molders; must be a good mechanic; good manager; able to secure results and make good work; state age, experience, references, salary and full particulars. Box 41, AMER. MACHINIST.

Wanted—Foreman machinist, thoroughly familiar with the manufacture of pneumatic hammers; he must be capable of handling men and machines to get out work up to date; steady work and good pay to right man; state age and references. Address Box 40, AM. M.

Wanted—Thoroughly competent foreman on machine tool building, experienced in building pipe threading machinery, familiar with methods of producing duplicate parts on turret lathes; give age, experience, salary expected and references. Box 28, AMER. MACH.

Wanted—A first-class patternmaker to work at the bench and have general supervision over the pattern shop; position in a Southern city of 20,000 inhabitants; new modern shop now being erected; a permanent place for the right man; good wages and good treatment guaranteed. Box 8, AMER. MACH.

Wanted—A strictly first-class machine tool designer; must have held important position with some of the leading heavy machine tool builders; none but steady, capable men, married preferred, who are looking for a permanent position, need apply; give age and state fully experience. Address Box 30, AM. MACH.

Wanted—Superintendent, by a leading Canadian company, manufacturing pumping machinery; about 150 hands; must be a man of exceptional ability, able to organize all departments and force production; experience in our line necessary; young man preferred; state age, experience, salary required; send testimonials. Apply "Toronto," care AM. MACH.

Wanted—A mechanical engineer as foreman, by a concern manufacturing high and medium speed automatic engines, also plain slide valve engines, to take full charge of this department; applicant must have first-class ideas and executive ability in handling men; the factory manufactures engines exclusively; give age, address and references. Box 27, AMERICAN MACHINIST.

Wanted—Boiler shop foreman, capable of taking charge of shop working from 75 to 100 men at present and will build new plant during the coming year; must have experience in construction of locomotive boilers and tank work, also the use of hydraulic and air tool equipment of the latest design; a first-class position for the proper party. Address "Locomotive Works," care AMERICAN MACHINIST.

Wanted.—Machinists, toolmakers, draftsmen, do you want to increase your salary? They all say that Saunders' enlarged edition "Hand Book Practical Mechanics" exactly fills the bill for valuable shop kinks, rules, etc., figured out by simple arithmetic and drawings; also most complete reference tables in existence, many taken from note books of best mechanics in the country. Pocket size. Price, post paid, only $1, cloth; $1.25 leather. Agents wanted. Book sells itself. Big money. C. H. Saunders, 216 Purchase st., Boston, Mass.

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Le Blond Mach. Tool Co., R. H., Cincinnati, O.
Potter & Johnston Co., Pawtucket, R. I.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill
Almond, T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cushman Chuck Co., Hartford, Ct.
The E. Horton & Sons Co., Windsor Locks, Conn.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Trump Bros. Mach. Co., Wilmington, Del.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Standard Tool Co., Cleveland, O.

Chucks, Lathe
Cushman Chuck Co., Hartford, Ct.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
The E. Horton & Sons Co., Windsor Locks, Conn.
Skinner Chuck Co., New Haven, Ct.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mach. Co., D. E., New London, Conn.

Clamps, Machinists'
Besly & Co., Chas. H., Chicago, Ill.

Clutches, Friction
Caldwell, Son & Co., H. W., Chicago, Ill.

Conveying Machinery
Brown Hoisting Mchry. Co., New York.
Hunt Co., C. W., West New Brighton, N. Y.

Collectors, Dust
Allington & Curtis Mfg. Co., Saginaw, Mich.

Coping Machines
Long & Allstatter Co., Hamilton, Ohio.

Countershafts
Builders' Iron Fdry., Provi., R. I.
Reeves Pulley Co., Columbus, Ind.
Wilmarth & Morman Co., Grand Rapids, Mich.

Couplings, Shaft
Stuart, R. J., New Hamburg, N. Y.

Counters, Machinery
Veeder Mfg. Co., Hartford, Ct.

Counting and Printing Wheels
Grant Mfg. & Mach. Co., Bridgeport, Conn.

Cranes
Brown Hoisting Mach. Co., N. Y. City.
Cleveland Crane & Car Co., Cleveland, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Franklin Portable Crane & Hoist Co., Franklin, Pa.
Maris Bros., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Wm., Philadel., Pa.
Whiting Foundry Equipment Co., Harvey, Ill.

Crank Pin Turning Machines
Underwood & Co., H. B., Phila, Pa.

Crucibles
Dixon Crucible Co., Jos., Jersey City, N. J.

Cutters, Milling
Boston Gear Wks., Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Gay & Ward, Athol, Mass.
Geometric Drill Co., Westville, Ct.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Ct.
Rogers, John M., Boat, Gage & Drill Works, Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Cutting off Machines
Franklin Mach. Wks., Phila., Pa.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Pratt & Whitney Co., Hartford, Ct.

Cutting off Tool
Armstrong Bros. Tool Co., Chicago, Ill.

Dies, Sheet Metal
Bliss Co., E. W., Brooklyn, N. Y.
Perkins Mch. Co., Boston, Mass.

Dresser, Emery Wheel
Wrigley, Thos., Chicago, Ill.

Drilling Machines, Bench
Barnes Co., W. F. & John, Rockford, Ill.

Drilling Machines, Boiler
Bickford Drill & Tool Co., Cincinnati, O.
Dallett & Co., Thos. H., Phila., Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Horizontal
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John., Rockford, Ill.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fosdick & Holloway Mach. Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Warner & Swasey Co., Cleveland, Ohio.

Drilling Machines, Multiple Spindle
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mch. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati Ohio.
Dallett & Co., Thos. H., Phila., Pa.
Garvin Mach Co., New York.
Harrington, Son & Co., Edwin., Philadelphia, Pa.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., N. Y. City.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros., Worcester, Mass.

Drilling Machines, Portable
Dallett & Co., Thos H., Phila., Pa.

Drilling Machines, Pneumatic
Cleveland Pneu. Tool Co., Cleveland, Ohio.
Standard Pneumatic Tool Co., Aurora, Ill.

Drilling Machines, Radial
Amer. Tool Wks. Co., Cincin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, Ohio.
Cleveland Punch & Shear Works Co., Cleveland, O.
Dreses, Mueller & Co., Cincin., O.
Fosdick & Holloway M. T. Co., Cincinnati, O.
Harrington, Son & Co., Edwin., Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Turret
Niles-Bement-Pond Co., New York.
Quint, A. D., Hartford, Conn.

Drilling Machines, Upright
Am. Tool Wks. Co., Cincinnati, O.
Baird Mch. Co., U., Pittsburgh, Pa.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Cincinnati Mach. Tool Co., Cin., O.
Dwight Slate Machine Co., Hartford, Conn.
Fosdick & Holloway Mach. Tool Co., Cincinnati, O.
Gould & Eberhardt, Newark, N. J.
Harrington & Son Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Sibley & Ware, South Bend, Ind.

Dynamos
C & C Electric Co., New York.
General Elec. Co., New York.
Jantz & Leist Elec. Co., Cincin., O.
Robbins & Myer Co., Springfield, O.
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
Triumph Elec. Co., Cincinnati, O.
Western Elec. Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.

Electric Motor Controllers and Starters
Cutler-Hammer Mfg. Co., Milwaukee, Wis.

Electrical Supplies
General Incan. Arc Light Co., New York.
Western Elec. Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.

Elevators
Albro-Clem Elevator Co., Philadelphia, Pa.
Howard Iron Wks., Buffalo, N. Y.
Morse, Williams & Co., Phila., Pa.

Elevating and Conveying Machinery
Caldwell & Son Co., H. W., Chicago, Ill.
Link Belt Machy. Co., Phila., Pa.

Emery Wheels
See Grinding Wheels.

Engines, Steam
Buffalo Forge Co., Buffalo, N. Y.
Chandler & Taylor Co., Indianapolis, Ind.
Frick Co., Waynesboro, Pa.
Rand Drill Co., New York.

Engines, Gas and Gasoline
Columbus Mach. Co., Columbus, O.
Foos Gas Eng. Co., Springfield, O.
Mietz, August, New York.
Monarch Gas Engine Co., Indianapolis, Ind.
New Era Iron Wks., Dayton, O.
Olds Motor Wks., Detroit, Mich.
Regal Gas Engine Co., Coldwater, Mich.
Springfield Gas Eng. Co., Springfield, O.
Stover Engine Wks., Freeport, Ill.
Struthers, Wells & Co., Warren, Pa.
Weber Gas & Gasoline Eng. Co., Kansas City, Mo.

Expanding Mandrels
Nicholson & Son, W. H., Wilkesbarre, Pa.

Fans, Exhaust
Buffalo Forge Co., Buffalo, N. Y.

Files and Rasps
Barnett Co., G. & H., Phila., Pa.
Nicholson File Co., Prov., R. I.

Fillers, Oil Can
The Winkley Co., Hartford, Conn.

Filters, Oil
Burt Mfg. Co., Akron, O.

Fittings, Steam
Crane Co., Chicago, Ill.
Crosby Steam Gage & Valve Co., Boston, Mass.
Jenkins Bros., New York.
Lunkenheimer Co., Cincinnati, O.
Walworth Mfg. Co., Boston, Mass.

Forges
Buffalo Forge Co., Buffalo, N. Y.

Forgings, Drop
Billings & Spencer Co., Hartford, Conn.
Crawshaw & Judd, Worcester, Mass.
Williams & Co., J. H., Brooklyn, N. Y.
Wyman & Gordon, Worcester, Mass.

Forgings, Hydraulic
Wyman & Gordon, Worcester, Mass.

Foundry Cupolas and Ladles
Northern Engineering Wrks., Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Whiting Foundry Equip. Co., Harvey, Ill.

Foundry Furnishings
Obermayer Co., S., Cincinnati, O.
Whiting Foundry Equip Co., Harvey, Ill.

Furnaces, Coal, Gas and Oil
Am. Gas Furnace Co., N. Y. City.

Gages, Recording
Bristol Co., Bridgeport, Conn.

Gages, Standard
Brown & Sharpe Mfg. Co., Providence, R. I.
Pratt & Whitney Co., Hartford, Ct.
Rogers, John M., Boat, Gage & Drill Works, Gloucester City, N. J.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb & Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Gages, Steam
Crosby Steam Gage & Valve Co., Boston, Mass.

Gas Producers
Am. Gas Furnace Co., N. Y. City.

Gear Cutting Machinery
Bickford Drill & Tool Co., Cin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Dwight Slate Mch. Co., Hartford Conn.
Fellows Gear Shaper Co., Springfield, Vt.
Gould & Eberhardt, Newark, N. J.
Newton Mch. Tool Wks., Phil., Pa.
Pratt & Whitney Co., Hartford Conn.

Gears, Cut
Bigram, Hugo, Philadelphia, Pa.
Boston Gear Wks., Boston, Mass.
Cleveland Gear Wks., Cleveland, O.
Fawcus Mach. Co., Pittsburgh, Pa.
Gleason Tool Co., Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott, Cleveland, O.
New Process Raw Hide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburgh, Pa.

Gears, Molded
Farrel Fdry & Mch. Co., Ansonia, Conn.
Greenwald Co., I. & E., Cincin., O.
Poole & Son Co., Robt., Baltimore, Md.

Gears, Rawhide
Boston Gear Wks., Boston, Mass.
Chicago Raw Hide Co., Chicago, Il.
New Process Raw Hide Co., Syracuse, N. Y.

Graphite Compounds
Dixon Crucible Co., Jos., Jersey City, N. J.

Grinder, Tool
Anderson Tool Co., Anderson, Ind.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Landis Tool Co., Waynesboro, Pa.
Safety Emery Wheel Co., Springfield, O.
Whitney Mfg. Co., Hartford, Ct.

Grinders, Center
Leland & Faulconer Mfg. Co., Detroit, Mich.

Grinders, Cock
Windsor Mach. Co., Windsor, Vt.

Grinder, Cutter
Cincinnati Milling Mach. Co., Cincinnati, O.
Garvin Mach. Co., New York.
Norton Emery Wheel Co., Worcester, Mass.
Rivett-Dock Co., Boston, Mass.

Grinders, Disc
Gorton Mach. Co., Geo., Racine, Wis.
Universal Mach. Co., Provi., R. I.

Grinders, Drill
Gorton Mach. Co., Geo., Racine, Wis.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding Machines
Anderson Tool Co., Anderson, Ind
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders' Iron Foundry, Providence, R. I.
Gorton Mach. Co., Geo., Racine, Wis.
Landis Tool Co., Waynesboro, Pa.
Norton Emery Wheel Co., Worcester, Mass.
Universal Mach. Co., Provi., R. I.
Webster & Perks Tool Co., Springfield, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding Wheels
Builders' Iron Foundry, Providence, R. I.
Carborundum Co., Niagara Falls, N. Y.
Hampden Cor. Wheel Co., Brightwood, Mass.
Norton Emery Wheel Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.

Grind Stones
Cleveland Stone Co., Cleveland, O.

Gun Barrel Machinery
Pratt & Whitney Co., Hartford, Ct.
Reed Co., F. E., Worcester, Mass.

Hack Saw Blades and Frames
Starrett Co., L. S., Athol, Mass.
West Haven Mfg. Co., New Haven, Conn.

Hack Saws, Power
Hoefer Mfg. Co., Freeport, Ill.

Hammers, Steam
Cleveland Punch & Shear Wks Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Pittsburgh Shear Knife & Mach. Co., Pittsburgh, Pa.

Hammers, Drop
Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Merrell Bros., Brooklyn, N. Y.
Niles-Bement-Pond Co., New York.
Perkins Mach. Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Ct.

Hammers, Pneumatic
Cleveland Pneumatic Tool Co., Cleveland, O.
Dallett & Co., Thos. H., Phila., Pa.
Standard Pneumatic Tool Co., Aurora, Ill.

Handles, Machine Tool
Schacht Mfg. Co., Cincinnati, O.

Heads, Exhaust
Burt Mfg. Co., Akron, O.

Heating Machines, Automatic
Am. Gas Furnace Co., 23 John st., N. Y. City.

Heating and Ventilating Apparatus
Buffalo Forge Co., Buffalo, N. Y.

Hoists, Electric
Pawling & Harnischfeger, Milwaukee, Wis.

Hoists, Hand
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic
Curtis & Co. Mfg. Co., St. Louis, Mo.
Northern Engineering Wks., Detroit, Mich.
Rand Drill Co., New York.
Standard Pneumatic Tool Co., Aurora, Ill.

Hoisting Machinery
Hunt Co., C. W., West New Brighton, N. Y.

Indicators, Steam
Crosby Steam Gage & Valve Co., Boston, Mass.

Injectors
Lunkenheimer Co., Cincinnati, O.

Inspection and Tests
Hunt Co., Robt. W., Chicago, Ill.

Instruments, Drawing
Keuffel & Esser Co., New York.

Jacks
Watson-Stillman Co., New York.

Joints, Universal
Baush Machine Tool Co., Springfield, Mass.
Gray & Prior Mach. Co., Hartford, Conn.

Key Seaters
Baker Bros., Toledo, O.
Chattanooga Mchy. Co., Chattanooga, Tenn.
Mitts & Merrill, Saginaw, Mich.

Keys, Machine
Standard Gage Steel Co., Beaver Falls, Pa.
Whitney Mfg. Co., Hartford, Ct.

Lamps, Arc
General Electric Co., N. Y City.
Gen. Incan. Arc Light Co., N. Y.
Lea Elec. Mfg. Co., Anderson, Ind.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.

Lathes, Bench
Faneuil Watch Tool Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Ct.

Lathe Dogs
Armstrong Bros. Tool Co., Chicago, Ill.
Le Count, Wm. G., So. Norwalk, Conn.
Schwickart, Ph., New York.

Lathes
American Tool Wks. Co., Cin., O.
Automatic Mach. Co., Bridgeport, Conn.
Baird Machy. Co., U., Pittsburgh, Pa.
Barker & Chard Mach. T. Co., Cincinnati, O.
Barnes Co., B. F., Rockford, Ill.
Barnes, W. F. & John, Rockford, Ill.
Bradford Mach. Tool Co., Cin., O.
Bullard Mach. Tool Co., Bridgeport, Conn.
Fay & Scott, Dexter, Me.

Lathes—*Continued*
Flather Planer Co., Mark, Nashua, N. H.
Garvin Mach. Co., New York.
Grant Tool Co., Franklin, Pa.
Harrington, Son & Co., Edwin., Philadelphia, Pa.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
McCabe, J. J., New York.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Reed Co., F. E., Worcester, Mass.
Schumacher & Boye, Cincinnati, O.
Sebastian Lathe Co., Cincin., O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
P. P. Silk Mach. Co., Cincin., O.

Link Belts
Jeffries Mfg. Co., Columbus, O.
Link Belt Engineering Co., Philaphia, Pa.

Lockers, Clothes
Merritt & Co., Philadelphia, Pa.

Locomotives, Shop
Hunt Co., C. W., West New Brighton, N. Y.

Lubricants
Dixon Crucible Co., Jos., Jersey City, N. J.

Lubricators
Bowen Mfg. Co., Auburn, N. Y.
Lunkenheimer Co., Cincinnati, O.

Machinery Builders, Special
Watson Mach. Co., Paterson, N. J.

Machine Screws
Worcester Mach. Screw Co., Worcester, Mass.

Machinists' Small Tools
Billings & Spencer Co., Hartford, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hammacher, Schlemmer & Co., New York.
Pratt & Whitney Co., Hartford, Ct.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

Mandrels, Solid
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Rogers, John M., Boat, Gage & Drill Works, Gloucester City, N. J.

Measuring Machines
Pratt & Whitney Co., Hartford, Ct.
Rogers, John M., Boat, Gage & Drill Works, Gloucester City, N. J.

Micrometer Calipers
Brown & Sharpe Mfg. Co., Providence, R. I.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb & Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Milling Attachments
The Adams Co., Dubuque, Iowa.
Cincinnati Milling Mach. Co., Cincinnati, O.
Kempsmith Mfg. Co., Milwaukee, Wis.

Milling Machines, Plain
American Tool Wks. Co., Cin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mach. Co., Cincinnati, O.
Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Kempsmith Mfg. Co., Milwaukee, Wis.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Whitney Mfg. Co., Hartford, Ct.

Milling Machines, Portable
Underwood & Co., H. B., Philadelphia, Pa.

Milling Machines, Bench
Faneuil Watch Tool Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Ct.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Universal
Amer. Tool Wks. Co., Cincin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mach. Co., Cincinnati, O.
Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Kempsmith Mfg. Co., Milwaukee, Wis.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Ct.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Heavy Horizontal
Beaman & Smith Co., Provi., R. I.
Franklin Mach. Wks., Phila., Pa.
Grant Tool Wks., Franklin, Pa.
Hendey Mach. Co., Torrington, Ct.
Ingersoll Mill. Mach. Co., Rockford, Ill.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.

Milling Machines, Vertical
Brown & Sharpe Mfg. Co., Providence, R. I.
Garvin Mach. Co., New York.
Newton Mach. Tool Wks., Philadelphia, Pa.

Molding Machines
The Adams Co., Dubuque, Iowa.
Tabor Mfg. Co., Philadelphia, Pa.

Motors, Electric
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Robbins & Myers Co., Springfield, Ohio.
Roth Bros & Co., Chicago, Ill.
Sprague Electric Co., New York.
Triumph Elec. Co., Cincinnati, O.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.

Nut Tappers
See Bolt and Nut Machinery.

Oilers
Bay State Stamping Co., Worcester, Mass.

Oil Cups and Covers
Besly & Co., C. H., Chicago, Ill.
Bowen Mfg. Co., Auburn, N. Y.
Crane Co., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
The Winkley Co., Hartford, Conn.

Packing, Metallic
U. S. Metallic Packing Co., Philadelphia, Pa.

Packing, Steam Joint
Jenkins Bros., New York.

Pans and Tote Boxes, Steel
Kilbourne & Jacobs Mfg. Co., Columbus, O.

Patterns, Wood
Gobeille Pattern Co., Cleveland, O.

Patent Solicitors
Baldwin, Davidson & Wight, Washington, D. C.
Bevans, James W., Washington, D. C.
Copp & Co., Washington, D. C.
Cromwell, W. H., Washington, D. C.

Pattern Letters
Butler, A. G., N. Y. City.

Pattern Shop Machinery
American Machinery Co., Grand Rapids, Mich.
Baker Bros., Toledo, O.
Fay & Scott, Dexter, Me.

Pipe Cutting and Threading Machines
Curtis & Curtis Co., Bridgeport, Conn.
Merrell Mfg. Co., Toledo, O.
Oster Mfg. Co., Cleveland, O.
Saunders' Sons, D., Yonkers, N. Y.

Pipe Fitters' Tools
Saunders' Sons, D., Yonkers, N. Y.
Standard Tool Co., Cleveland, O.

Pipe and Fittings
Crane Co., Chicago, Ill.

Planer Jacks
Armstrong Bros. Tool Co., Chicago, Ill.

Planers, Metal
Amer. Tool Wks. Co., Cincin., O.
Belmer-Eames Tool Co., Cin., O.
Betts Mach. Co., Wilmington, Del.
Cincinnati Planer Co., Cincin., O.
Cleveland Punch & Shear Wks. Co., Cleveland, O.
Detrick & Harvey Mch. Co., Baltimore, Md.
Flather Planer Co., Mark, Nashua, N. H.
Garvin Mach. Co., New York.
Gray Co., G. A., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Niles-Bement-Pond Co., New York.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Wks., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Ct.
Sellers & Co., Wm., Phila., Pa.
Whitcomb Mfg. Co., Worcester, Mass.
Woodward & Powell Planer Co., Worcester, Mass.

Planers, Portable
Underwood & Co., H. B., Philadelphia, Pa.

Presses, Hand
Pratt & Whitney Co., Hartford, Conn.

Presses, Hydraulic
Watson-Stillman Co., New York.

Presses, Power
Bliss Co., E. W., Brooklyn, N. Y.
Perkins Mach. Co., Boston, Mass.

Profilers
Garvin Mach. Co., New York.
Pratt & Whitney Co., Hartford, Ct.

Pulleys
Howard Iron Wrks., Buffalo, N. Y.
Poole & Son Co., Robt., Baltimore, Md.
Reeves Pulley Co., Columbus, Ind.

Pulleys, Friction Cone
Evans Friction Cone Co., Boston, Mass.

Pulleys, Speed Changing
Speed Changing Pulley Co., Indianapolis, Ind.

Pulley Turning and Boring Machines
Harrington, Son & Co., Edwin, Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.

Pumps, Hydraulic
Watson-Stillman Co., New York.

Punches, Hydraulic
Watson-Stillman Co., New York.

Punches, Power
Bremer Mach. & Tool Co., Kalamazoo, Mich.
Cleveland Punch & Shear Wks., Cleveland, O.
Hilles & Jones Co., Wilmington, Del.
Long & Allstatter Co., Hamilton, Ohio.
Perkins Mach. Co., Boston, Mass.
Pittsburgh Shear Knife & Mach. Co., Pittsburgh, Pa.

Racks, Cut
Standard Gage Steel Co., Beaver Falls, Pa.

Racks, Tool
New Britain Mach. Co., New Britain, Conn.

Rack Cutting Machines
Fellows Gear Shaper Co., Springfield, Vt.
Reed Co., F. E., Worcester, Mass.

Ratchet Drills
Curtis & Curtis Co., Bridgeport, Conn.
Parker Co., Chas., Meriden, Ct.

Reamers
Cleveland Twist Drill Co., Cleveland, O.
Geometric Drill Co., Westville, Ct.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Rogers, John M., Boat, Gage & Drill Wks., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Recorders, Speed
Starrett Co., L. S., Athol, Mass.

Riveters, Hydraulic
Watson-Stillman Co., New York.

Riveting Machines
Bethlehem Foundry & Mach. Co., So. Bethlehem, Pa.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Riveters, Pneumatic
Standard Pneumatic Tool Co., Aurora, Ill.

Roller and Ball Bearings
Ball Bearing Co., Boston, Mass.
Roller Bearing & Equip. Co., Keene, N. H.

Rolling Mill Machinery
Cleveland Punch & Shear Wks. Co., Cleveland, O.

Rotary Planers
Underwood & Co., H. B., Phila.,Pa.

Safety Valves, Pop
Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

Sand Mixing Machines
Sellers & Co., Wm., Phila., Pa.

Sawing Machines, Metal, Circular
Cleveland Punch & Shear Works Co., Cleveland, O.
Newton Mach. Tool Works, Philadelphia, Pa.

Schools, Correspondence
Consolidated Schools, N. Y. City.
International Correspon. Schools, Scranton, Pa.

Schools, Technical
Ohio State University, Columbus, Ohio.

Screw Plates
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Card Mfg. Co., S. W., Mansfield, Mass.
Hart Mfg. Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Oster Mfg. Co., Cleveland, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Second Hand Machinery
Bowler & Co., Geo. H., Cleveland, Ohio.
Dawson, John H., Chicago, Ill.
Doan & Co., J. B., Chicago, Ill.
Fairbanks Co., Philadelphia, Pa.
Garvin Mch. Co., New York.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mchy. Co., Chicago, Ill.
McCabe, J. J., New York.
Pitkin Machy. Co., J. B., Providence, R. I.
Prentiss Tool & Supply Co., New York.
Toomey, Frank, Philadelphia, Pa.
Wormer Machy. Co., C. C., Detroit, Mich.

Separators, Oil
Amer. Tool & Mch. Co., Boston, Mass.
Springfield Separator Co., Springfield, Vt.

Shapers
Amer. Tool Wks., Co., Cincin., O.
Cincinnati Shaper Co., Cincin., O.
Flather Planer Co., Mark, Nashua, N. H.
Garvin Mach. Co., New York.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., Boston, Mass.
Kelly Co., R. A., Xenia, Ohio.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Perkins Mach. Co., Boston, Mass.
Potter & Johnston Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Ct.
Steptoe & Co., John, Cincinnati, O.

Shears, Power
Bliss Co., E. W., Brooklyn, N. Y.
Bremer Mach. & Tool Co., Kalamazoo, Mich.
Cleveland Punch & Shear Wks., Cleveland, O.
Hilles & Jones Co., Wilmington, Del.
Long & Allstatter Co., Hamilton, Ohio.
Perkins Mach. Co., Boston, Mass.
Pittsburgh Shear Knife & Mch. Co., Pittsburgh, Pa.

Shears, Rotary
Bethlehem Foundry & Mach. Co., So. Bethlehem, Pa.
Bliss Co., E. W., Brooklyn, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Perkins Mch. Co., Boston, Mass.

Shop Shelving and Tool Holders
New Britain Mach. Co., New Britain, Conn.

Slotters
Baker Bros., Toledo, Ohio.
Betts Mach. Co., Wilmington, Del.
Garvin Mach. Co., New York.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.

Springs
Cleveland Wire Spring Co., Cleveland, O.

Sprocket Chains
See Driving Chains.

Stamps, Letters and Figures
Schwerdtle Stamp Co., Bridgeport, Conn.

Stampings, Sheet Metal
Automobile & Cycle Parts Co., Cleveland, O.
Bliss Co., E. W., Brooklyn, N. Y.

Steel, Sheet
Automobile & Cycle Parts Co., Cleveland, O.

Steel, Machinery
Ward & Son, Edgar T., Boston, Mass.

Straightener, Hydraulic
Watson-Stillman Co., N. Y. City.

Swaging Machines
Excelsior Needle Co., Torrington, Conn.

Switchboards
C & C Electric Co., New York.
Triumph Elec. Co., Cincinnati, O.

Tapping Machines and Attachments
Baker Bros., Toledo, O.
The Beaman & Smith Co., Providence, R. I.
Bickford Drill & Tool Co., Cin., O.
Cincinnati Mach. Tool Co., Cincinnati, O.
Errington, F. A., N. Y. City.
Fosdick & Holloway Mach. Tool Co., Cincinnati, O.
Fulton Fdry. & Mach. Co., Brooklyn, N. Y.
Garvin Mach. Co., New York.
Geometric Drill Co., Westville, Ct.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Taps and Dies
Besly & Co., Chas. H., Chicago, Ill.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Crane Co., Chicago, Ill.
Hart Mfg. Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Oster Mfg. Co., Cleveland, O.
Standard Tool Co., Cleveland, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Threading Dies, Opening
Errington, F. A., New York.
Geometric Drill Co., Westville, Ct.
Jones & Lamson Mch. Co., Springfield, Vt.

Thread Cutting Tools
Rivett-Dock Co., Boston, Mass.

Tool Grinders
Gisholt Mach. Co., Madison, Wis.
Leland & Faulconer Mfg. Co., Detroit, Mich.

Tool Holders
Armstrong Bros. Tool Co., Chicago, Ill.

Tools
See Machinists' Small Tools.

Transmission Machinery
Caldwell & Son Co., H. W., Chicago, Ill.
Link-Belt Engineering Co., Philadelphia, Pa.
Reeves Pulley Co., Columbus, Ind.

Trolleys and Tramways
Brown Hoisting Machy. Co., N. Y. City.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hunt Co., C. W., West New Brighton, N. Y.
Link Belt Engineering Co., Philadelphia, Pa.
Maris Bros., Philadelphia, Pa.
Pawling & Harnischfeger, Milwaukee, Wis.
Yale & Towne Mfg. Co., New York.

Turret Machines
Amer. Tool & Mch. Co., Boston, Mass.
Automatic Mach. Co., Bridgeport, Conn.
Barker & Chard M. T. Co., Cin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Mach. Tool Co., Bridgeport, Conn.
Cleveland Mach. Screw Co., Cleveland, O.
Dreses, Mueller & Co., Cincin., O.
Fay & Scott, Dexter, Me.
Garvin Mach. Co., New York.
Gisholt Mch. Co., Madison, Wis.
Grant Tool Co., Franklin, Pa.
Hill, Clarke & Co., Boston, Mass.
Jones & Lamson Mch. Co., Springfield, Vt.
Lodge & Shipley Mach Tool Co., Cincinnati, O.
Pearson Mach. Co., Chicago, Ill.
Potter & Johnston Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Ct.
Warner & Swasey Co., Cleveland, Ohio.
Windsor Mach. Co., Windsor, Vt.

Twist Drills
Cleveland Twist Drill Co., Cleveland, O.
Etna Mfg. Co., New York.
Morse Twist Drill & M. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.

Valves
See Steam Fittings.

Vises, Wood Workers'
Wyman & Gordon, Worcester, Mass.

Vises, Metal Workers'
Howard Iron Wks., Buffalo, N. Y.
Parker Co., Chas., Meriden, Conn.
Prentiss Vise Co., New York.
Walworth Mfg. Co., Boston, Mass.

Vises, Pipe
Saunders' Sons, D., Yonkers, N. Y.
Walworth Mfg. Co., Boston, Mass.

Vises, Planer and Shaper
Cincinnati Planer Co., Cincin., O.
Hendey Mach. Co., Torrington, Ct.

Welding Machines
Long & Allstatter Co., Hamilton, Ohio.

Wood and Lag Screw Machinery
Baker Bros., Toledo, Ohio.
Cook Co., Asa S., Hartford, Conn.

Wood Trimmers
Amer. Mchry Co., Grand Rapids, Mich.
Leland & Faulconer Mfg. Co., Detroit, Mich.

Wrenches, Drop Forged
Williams & Co., J. H., Brooklyn, N. Y.

Worm Hobbing Machines
Grant Tool Wks., Franklin, Pa.

Worm Gearing
Albro-Clem Elevator Co., Philadelphia, Pa.
Fawcus Mach. Co., Pittsburgh, Pa.
Morse, Williams & Co., Phila., Pa.
Nuttall Co., R. D., Pittsburgh, Pa.

Worm Milling Machines
Cleveland Mach. Screw Co., Cleveland, O.

The Gathmann Gun Tests.

BY GRAHAME H. POWELL.

Some confusion seems to have arisen as to the real object of the recent test at the government proving ground at Sandy Hook of the Gathmann system of throwing high explosives. This confusion has in large measure been due to the fact that the gun employed in the Gathmann experiments happened to be probably the largest weapon ever constructed, and on this account received a great deal of newspaper notoriety, with the result that the real object of the test was obscured.

Gathmann has long contended that the detonation of a large charge of an insensitive high explosive on the outside of a battleship would mean the crushing in of the vessel to such an extent as to cause it to sink immediately. This was the theory of outside versus inside explosion.

Backed by influential friends, Gathmann finally in March, 1899, obtained from Congress an appropriation of $75,000 for the construction of an 18-inch gun and to procure the necessary powder and projectiles for a test. This appropriation was supplemented in 1901 by a further sum of $50,000 for a comparative test of the Gathmann system with an army 12-inch service rifle.

Under this latter appropriation two identical structures were built to represent one of the side plates of a modern battleship. These plates were of Kruppized steel, 16x7½ feet by 11½ inches thick, constructed by the Carnegie Steel Company, and constituted the targets used in the firing test.

The Gathmann system consists in a shell to contain a large quantity of explosive with means for projecting the same from a powder gun and detonation of the charge against its target. In Fig. 1 is shown a sectional view of the Gathmann shell or torpedo. It is 6 feet in length and 15 inches in interior diameter, the walls being only 1½ inches in thickness on the sides, tapering to 7-10 inch near the forward end. It is designed to contain 560 pounds of wet gun cotton, of which 30 per cent. is water, as in the dry state this composition is very sensitive to shock. A central channel *A*, closed with a screw plug, provides

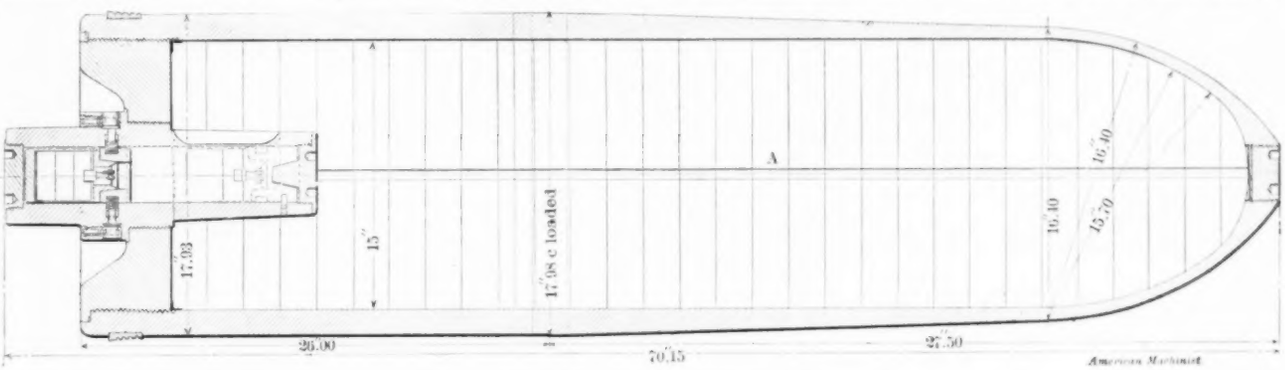


FIG. 1. GATHMANN TORPEDO.

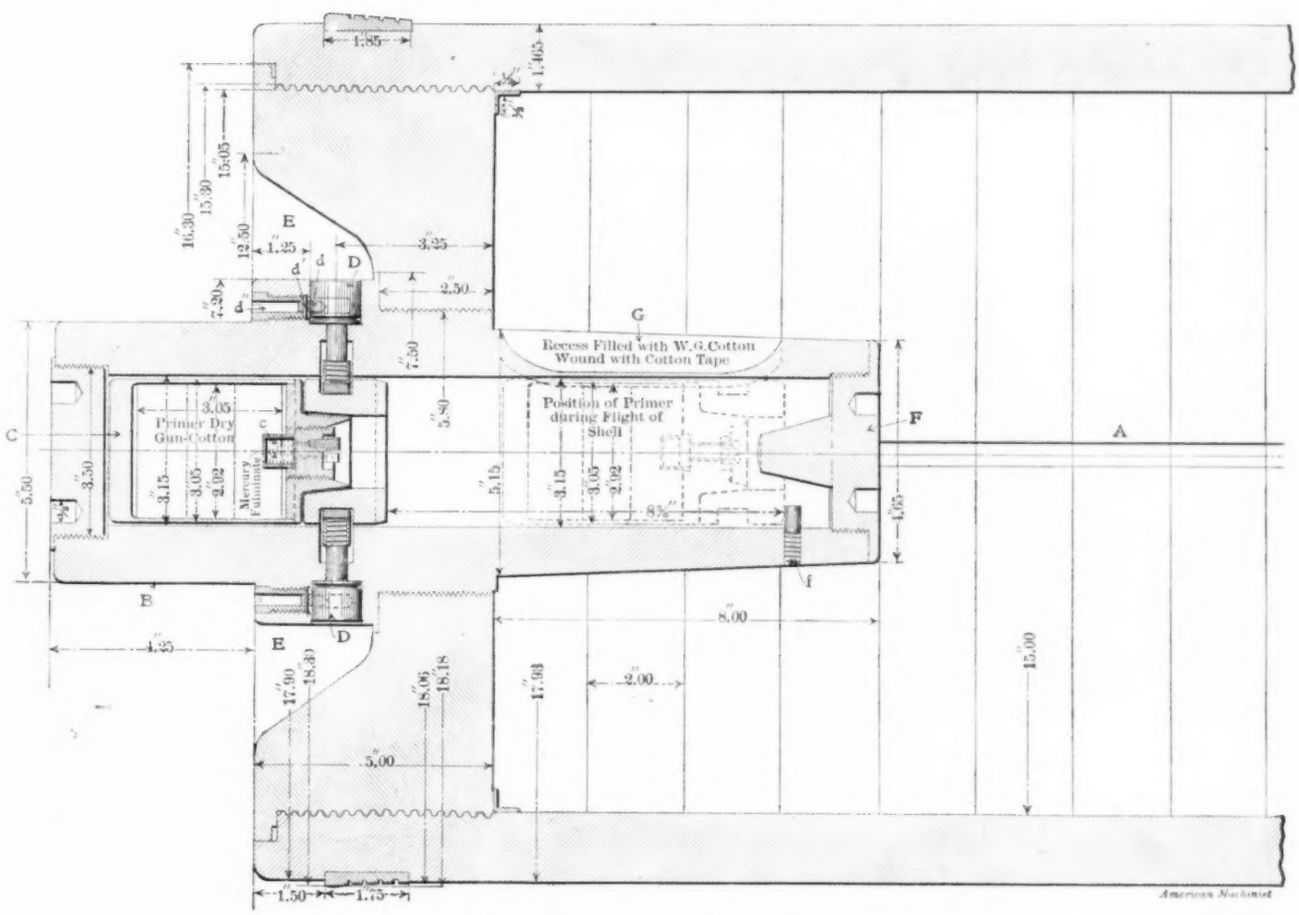


FIG. 2. REAR END OF GATHMANN TORPEDO.

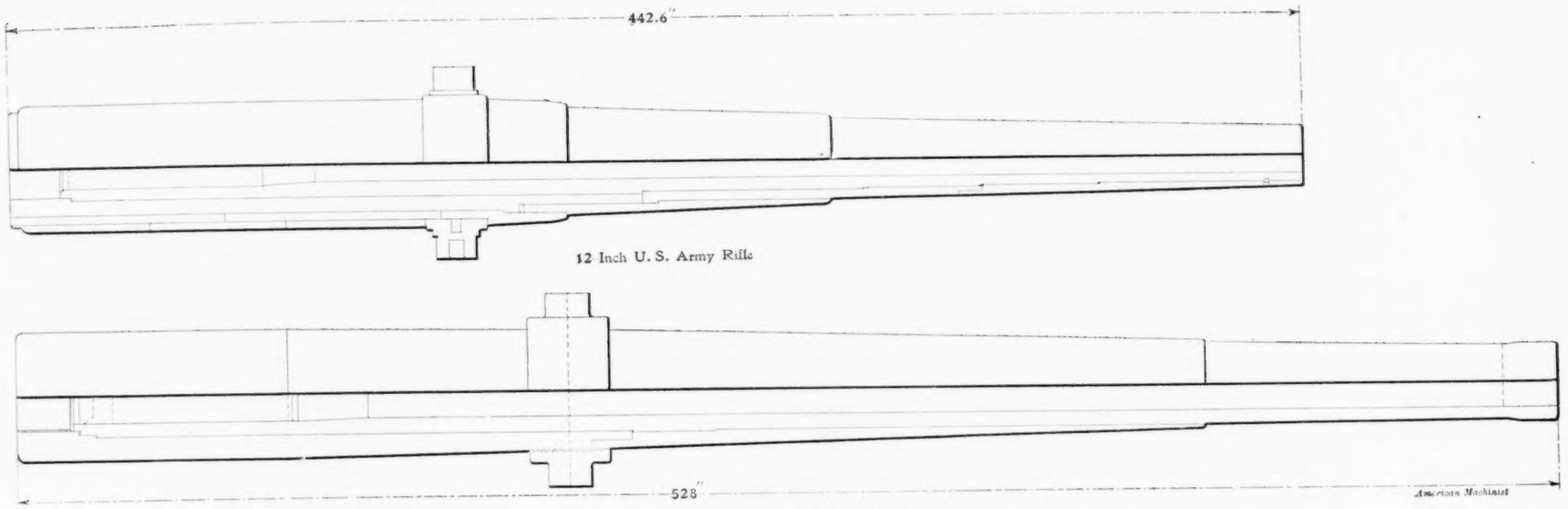


FIG. 3. COMPARATIVE ILLUSTRATIONS OF GUNS TESTED.

			GATHMANN 18-INCH	SERVICE 12-INCH
Weight		Tons	59.6	51
Total length		Feet	44	36.88
Maximum diameter, breech		Inches	45	44.5
Diameter of muzzle		Inches	27.5	21
Rifling,	Number of grooves		96	72
	Width " "	Inches	0.419	0.3736
	Depth " "	"	0.06	0.06
	Width of lands	"	0.17	0.15
	Twist		1 in 100 to 1 in 25*	1 in 50 to 1 in 25
Projectile,	Kind		Torpedo	A. P. shot
	Weight, filled	Pounds	1,860	1,000
	Ratio, weight to weight of piece		1/100*	1/117
	Bursting charge	Pounds	560**	20⅝
	Length, calibers		4	3.5
Powder	Kind		Nitroglycerine	Nitrocelluose
	Weight	Pounds	300	240
Muzzle velocity		Foot-seconds	2,100	2,300
Pressure per square-inch		Pounds	20,000	37,000

* To within 35 inches of muzzle from which point twist is uniform.

** Wet gun cotton. ⅝ Explosive D.

COMPARATIVE TABLE OF GATHMANN AND 12-INCH SERVICE GUNS.

means for keeping the cotton constantly wet.

Wet gun cotton can be successfully detonated only by a primer of dry gun cotton, so that after all the real point of the Gathmann system lies in the fuse which contains the priming charge. This is shown in Fig. 2. *A* is the base plug into which is screwed the fuse *B*. Within the fuse is a cylindrical case *C* which contains the primer of 12 ounces of dry gun cotton, with a detonator *c* of 45 grains of fulminate of mercury in a disk of 0.65 inch in diameter and 0.25 inch thick. This case *C* is free to move forward, except for the pins *D D*, which are held in place by a small plug *d* fastened by a wire *d'*, which is sheared by the powder gas pressing on the plug *d* through the opening *d''*. When the shell is fired from the gun the powder gas presses on the heads of the pins *D D* through the recess *E*. This pressure continues while the shell is in the gun, but is removed once the torpedo is free of the muzzle, when the twisting motion of the shell, caused by the rifling of the gun, causes the pins to fly outward and the primer case *C* is free to move forward. Having the same initial velocity as the shell and not being subject to retardation by atmospheric conditions, this case does move forward until it comes in contact with the brass pin *f* which holds the detonating cap *c* from contact with the anvil *F* until the shell strikes an obstruction, when the pin *f* is sheared by the forward movement of the primer case, which detonates the fulminate cap, exploding the primer of dry cotton, rupturing the thin recessed walls *G* of the forward part of the fuse and the wet gun cotton is detonated as the torpedo crushes up against the face of the target. There are three of these recesses, each 6 inches in length.

The safety feature of this fuse lies in the fact that even should the primer of dry

cotton be detonated by any possibility while in the gun, no harm would result, as the primer is not in contact with the main charge and such explosion would be insufficient to rupture the thick walls of the base of the fuse where the primer case is held until the shell has left the gun.

While not primarily the object of the recent test, the Gathmann gun itself is an interesting piece of ordnance, from the fact that it is of such exceptional caliber.

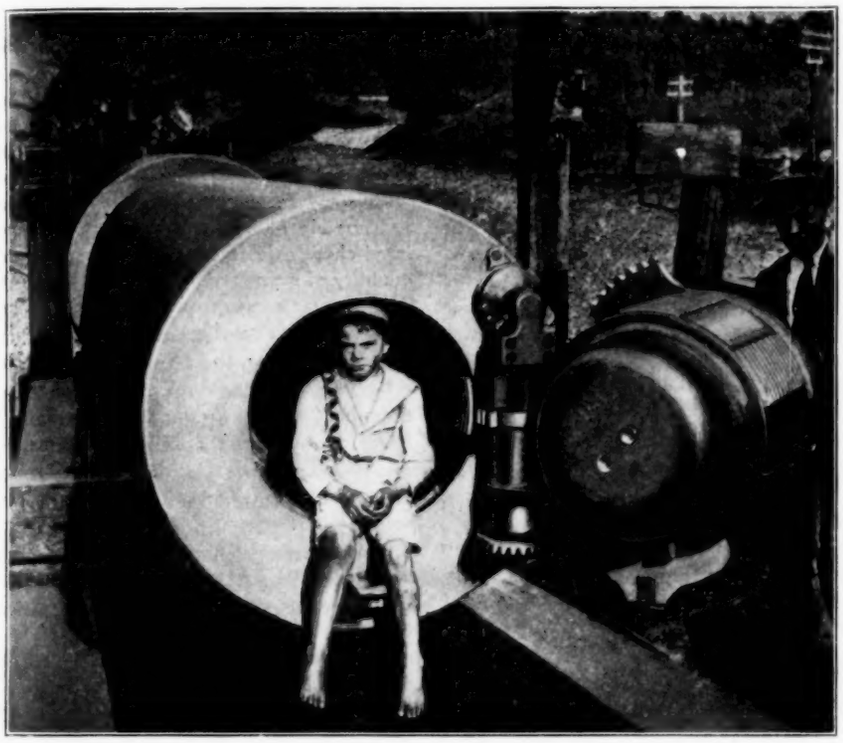


FIG. 4. BREECH OF GATHMANN RIFLE.

In order to carry such a large quantity of insensitive explosive as 500 pounds it was necessary to design a very large shell, and this in turn necessitated an equally large caliber gun; hence the 18-inch Gathmann weapon.

This gun if carried out proportionately would be more than three times the size of the 12-inch service rifle, in competition with which it was tested. This, however, was not necessary, the shell of the Gathmann gun, fully charged, weighing approximately 2,000 pounds, against the 1,000 pounds of the service projectile.

The illustration, Fig. 3, shows graphically the comparative size of the two weapons, while the accompanying table gives the dimensions and other data relative to each.

This table shows that the Gathmann gun is designed to withstand much lower powder pressures than the 12-inch rifle. This is because the destructive force of the shell is derived from the contained explosive and not from the striking energy of the projectile as in the service weapon. The lower powder pressures to which the gun is subjected also accounts for the much simpler construction of the Gathmann gun, four parts to the twelve of the 12-inch rifle.

One particular in which the Gathmann gun differs from other rifles is that the rifling does not start abruptly from the powder chamber, but increases gradually to its full depth, the inventor claiming that less of a shock is transmitted to the shell by this method. The gun was designed and constructed at the works of the Bethlehem Steel Company, South Bethlehem, Pa.

The results of the tests of the two systems referred to—that is, outside against inside explosion—has been so extensively described in the daily press that a mere mention of the facts is sufficient.

Three shots were fired at the Gathmann target. The first struck the target in the center, but had no appreciable effect on the plate. The second shot struck near the right-hand edge of the plate, forcing it bodily into the backing about 35 inches at the right-hand end and 12 inches at the opposite end. The third shot, fired at the left-hand edge of the target, was the most successful of all, forcing the whole structure 8 feet to the rear and 8 feet to the left, and breaking it in two vertically through the center of impact of the second shot.

The first round fired from the 12-inch service rifle was a 1,000-pound armor-piercing shot containing 20 pounds of a new explosive invented by Capt. B. W. Dunn, of the army. The shot struck the plate in the center and exploded as it passed through, tearing a conical shaped hole in the plate and blowing a large cavity in the supporting structure.

The second round was an A. P. shot loaded with 25 pounds of Maximite. It struck the plate near the right-hand end, penetrated and burst in passing through, further demolishing the backing. It completely wrecked the plate, cracking it both vertically and horizontally. A third round was fired, consisting of an A. P. shell loaded with 65 pounds of Explosive D, further demolishing the already weakened target.

The half-tone illustrations show the breech of the Gathmann gun and the appearance of its target before and after firing.

FIG. 5. GATHMANN TARGET BEFORE FIRING.

For the successful working of aluminum a lubricant is usually desirable. For lathe work use mineral oils or water, and for drawing or stamping in the press vaseline is best; this on the authority of "The Aluminum World."

Points to be Observed in Case Hardening.

BY E. R. MARKHAM.

The term *case hardening* explains itself. By the operation a *case of steel* is formed on the outside of the piece treated and when it is heated red hot and plunged in the bath becomes hard, as with other steel.

FIG. 6. GATHMANN TARGET AFTER THIRD IMPACT.

The stock used to make the articles of varies widely. Generally speaking, anything lying around the shop that will do is used, or, if nothing can be found, the hardware house that supplies most of the stock is called up and a conversation similar to the following ensues:

"Hello, hello, Mr. Hardwareman. Have you got any stock on hand the size I want? Any old thing will do, as long as it's cheap and soft enough to work well. Oh, no; we are not going to harden it; don't want tool steel, can't pay the price. We're going to case harden it; don't make any difference about the grade, only we want it soft. It *must* be soft. Two cents and a half a pound! Haven't you got anything cheaper? We paid only two and a quarter last time. Say, that last stock didn't harden very well, but I guess it was the fault of our man: he must have run it too long. The pieces don't stand up well. Did we ever try open-hearth stock? No; how much is it? Two and three-quarters! Can't stand it. Well, send us the two and a half cent stock."

Now, as a matter of fact, it is necessary to use the same care in selecting stock that is to be case hardened, as when deciding on a particular brand of tool steel to use for a certain purpose. If the pieces to be hardened are to resist frictional wear and will not be subjected to blows or jar of any kind, almost any stock will do. But if they are to be subjected to such shocks as the parts contained in the breech mechanism of a gun receive, it will be very necessary to use great care in the selection of the stock and the material we use in giving it the necessary hardening qualities.

A careful study of the composition and peculiarities of steel will teach one that *phosphorus*, when it occurs in any considerable quantities, is the most injurious of all the elements which usually contaminate iron and steel. It confers hardness, it is true, but that can be far more satisfactorily obtained, when desired, by the addition of other elements. The injurious effects of phosphorus are especially noticeable when the steel also contains carbon in any amount. The higher the percentage of carbon the more brittle the steel becomes as phosphorus is added. It causes what is known among steel makers as cold shortness, or brittleness when cold. If it is necessary to harden pieces of large size to a considerable depth, in order to make them stiff and able to resist blows or similar surface action, it is best to get a steel high enough in carbon to give the desired effect when hardened. The outside surface can be given any degree of additional hardness by packing in a box with some carbonizing element that does not contain phosphorus. I prefer granulated charred leather mixed with an equal quantity of granulated charcoal. The depth it penetrates depends on the length of time it is subjected to the heat. If toughness is desired the pieces may be quenched in a bath of raw linseed oil, which will make them hard enough for most purposes.

An analysis of the different forms of bone used for case hardening will show them to be very rich in phosphorus, and so totally unfit for use in connection with steel containing much carbon, or where brittleness would be objectionable.

I was once consulted by a representative of a bicycle concern, who were having a great amount of trouble with the bevel gears used in their chainless wheels. They were using what was known as a forty-point carbon, open-hearth steel, packing the gears in various grades of bone and

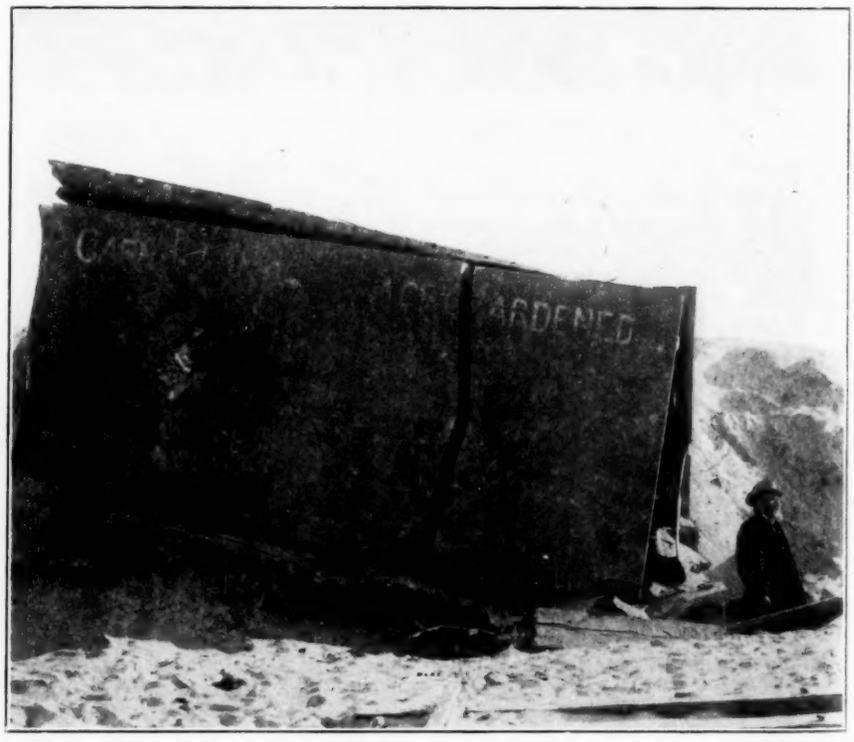


FIG. 7. GATHMANN TARGET AFTER THIRD IMPACT.

charcoal, sometimes hardening at the first heat and sometimes giving them a second heat to harden, as described in the article on "case hardening for fine grain." The results were far from satisfactory. I recommended using charred leather in place of bone, and hardening in raw linseed oil at the first heat. They had no further trouble.

I would say in conclusion that if more attention were paid in many manufacturing establishments to these *minor* points—as they are often considered—the balance sheet might make a different showing at the end of the business year. The man in charge of the hardening department should be as brainy as the man in charge of the buying and selling department. He should understand the composition and peculiarities of the stock and materials used in his work and not be obliged through ignorance to work by the rule of guess.

Experiments on the Flexure of Beams—Discovery of New Laws—V.

BY ALBERT E. GUY.

EXPERIMENTS (CONCLUDED.)

My first experiments were made upon beams supported at the ends and loaded at the center. In the absence of data concerning the question, it was thought that the beams buckled because they were long and thin—that is, *structurally weak*—but soon after the start it was observed that they obeyed a certain law. It was found also that the manner of applying the load had a great influence on the results. Thus, with a very thin beam, if the load is applied at the middle, but resting on the upper face, the system is very unstable, because the bending force, acting above the center of gravity of the beam, tends to upset this latter without actually buckling it. If the load is suspended by means of a wire terminated by a ring or a loop passing around the beam and resting on the upper face at the middle of the length, the center of gravity of the system is very low, and it would seem that the equilibrium is assured; but it is not so, and the beam is as unstable as in the first case, because the least oscillation of the load may cause an oblique pull on the upper edge, and thus upset the beam. After trying different methods for applying the load, one was found to give very regular results and was consequently adopted for all the experiments. It is the same as the one used with the apparatus illustrated in Fig. 5, Part III. Two thin strips of wood, Fig. 12, were fastened at one end to the beam by a small bolt and nut, the bolt passing through a hole bored at the middle of the hight h on the neutral axis of the beam, and at the other end the load was suspended. The beam and load were thus solidly connected. In order to still further increase the stability of the system the ends of the beams were cut in such a way that, previous to the application of the load and barring the small deflection due to the weight of the beam itself, the points of support and the center of suspension of the load were situated on the same horizontal line, viz., the longitudinal axis of the beam. This excess of care naturally developed an increase of the elastic equilibrium of the specimen, but this was not especially noticed until the difficulties encountered in the angular tests exposed the true guiding action of the suspension strips. We have seen that when a beam supported at the ends buckled, the points of support and of suspension remained in the same vertical plane, but the beam assumed a double curvature in the form of an elongated S. This very misleading double curvature was caused entirely by the suspension strips, which, forcing the center of the beam to remain in a vertical plane, effectively prevented it from twisting. Furthermore, the beam in developing one loop on each side of its axis increased the static stability of the system and caused an augmentation of the buckling board.

After the suspension parallelogram was devised and applied with such successful results to the beams held at one end and loaded at the other, the question clearly defined itself. The work done previously had been spent on a complex case; that is, a beam supported at the ends had supported at the middle of its length a load which guided it in a vertical plane. This case resembles somewhat that of a vertical column held at the base and sustaining at the top an axial load guided vertically.

It was then necessary to make anew the previous tests, this time employing the parallelogram in order to let the beam deviate or twist freely. The results were at once convincing, and the three laws were almost perfectly verified. The load observed for a beam of length L was found to be that necessary to buckle the same beam supported at one end and loaded axially at the other, as per Euler's formula:

$$P = \frac{\pi^2 E I}{L^2}$$

In table 5, P is the load observed as applied with the strips, and P_0 is the theoretical load deduced from the above formula, and with which that applied by means of the parallelogram almost perfectly coincided.

In table 6 we have the results obtained with a built-up I-beam. The top and bottom flanges were glued to the web, and formed a solid combination. The load was attached to a strong wooden bar which had an end cut out so as to fit exactly the shape of the beam. This method was thought the best at the time, but afterward the parallelogram was tried and the observed loads again coincided with the theoretical ones given in the P_0 column.

In table 7 are given the results obtained with a built-up T-beam. The load was applied by means of a strong bar cut to fit

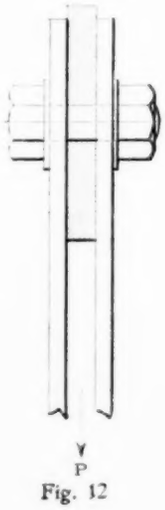


Fig. 12

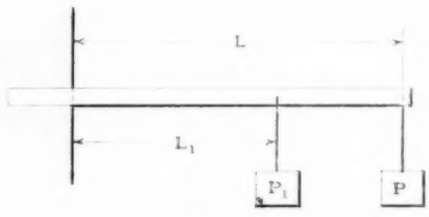


Fig. 13

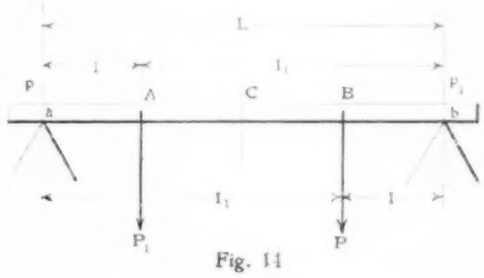


Fig. 14

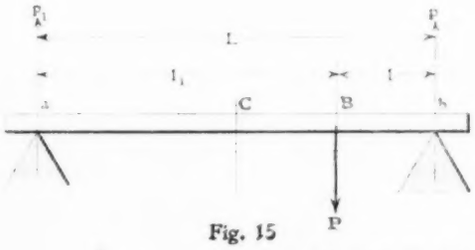


Fig. 15

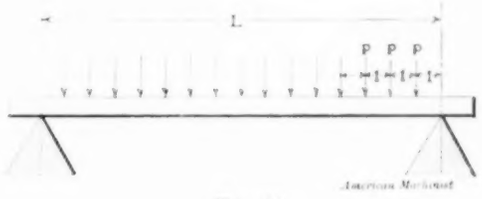


Fig. 16

VARIOUS METHODS OF LOADING BEAMS.

the shape of the beam. But in the first position (⊥) the bottom flange was left free, the bar being fitted only to the vertical web. The different values observed in the two positions would seem at first to indicate that the beam can resist better in one position than in the other. But these differences are due to the guiding influence of the suspension bar, and also to friction at the supports. In the T position the load acts upon a flat horizontal surface and tends to keep it in the same plane, while the web is guided also vertically, consequently the resistance of the beam is somewhat higher than in the other position. This can be made clear by using the parallelogram, with which we would find the resistance alike for both positions were it not for the friction at the supports, the loads coinciding with the theoretical P_o.

In these tables we see the gradual increase of the stress f. This stress does not seem to exert any influence upon the resistance of the solid, for the beam buckles only when the product of the load into the square of the length equals a certain constant.

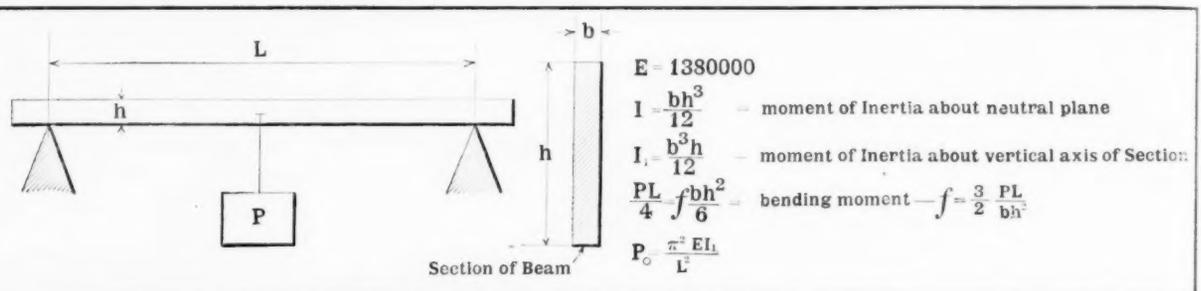
A large number of tables could be added to those already cited, which would give the results of experiments performed on many specimen of various forms and on a few steel beams, but the writer, satisfied for himself that the laws advanced in this memoir have been verified, and certain that the present question will interest the mechanical world, would prefer to see the matter taken up by competent investigators, having at their disposal perfect testing apparatus, and who would confirm his own work or indicate necessary modifications of the formulas given here.

Since the theoretical laws of Euler seem to govern the question, *the experiments, in order to be conclusive, must conform absolutely to the requirements of the theory.* Thus, the limits of elasticity must not be trespassed, and the specimen must be held or supported and loaded *exactly* as the theory requires. It is proverbial that every rule has its exceptions, but in our case the rule or law, pure and simple, must be firmly established at first, and it will be easy afterwards to study the exceptions or complex cases, one by one, as they are encountered in practice.

The first law of the elastic equilibrium of solids is very remarkable. It shows that a beam will buckle, whatever be its length, if the load applied is such that the relation $PL^2 =$ constant is satisfied; if $L = o$, $P = \infty$, and vice versa.

No less remarkable is the fact, proved by the angular tests, that the separate effects of one force unite into a common effort tending to destroy the equilibrium. From careful consideration of this fact results the finding of the key to many problems heretofore unsolved.

Since the components of one force, being in fact two distinct forces acting at the same point, combine their efforts, we may logically deduce therefrom that the efforts of two or more forces acting at various points on the beam may also combine towards the same object.


L
h
P
b
h
Section of Beam
E = 1380000
$I = \frac{bh^3}{12}$ = moment of Inertia about neutral plane
$I_1 = \frac{b^3h}{12}$ = moment of Inertia about vertical axis of Section
$\frac{PL}{4} f \frac{bh^2}{6}$ = bending moment — $f = \frac{3}{2}\frac{PL}{bh^2}$
$P_o = \frac{\pi^2 EI_1}{L^2}$

	b = 1/8" h = 1/4"					b = 0.19" h = 1 1/4"					b = 3/16" h = 2"				
L	P	PL^2	$\frac{PL}{4}$	f	P_o	P	PL^2	$\frac{PL}{4}$	f	P_o	P	PL^2	$\frac{PL}{4}$	f	P_o
34"						12.5	14450.	106.25	2147.4	8.42	19.	21964.	161.5	1292.	12.94
32						14.5	14848.	116.	2344.4	9.5	22.	22528.	176.	1408.	14.61
30	4.625	4162.5	34.68	1065.6	3.08	16.	14400.	120.	2425.2	10.81	26.	23400.	195.	1560.	16.62
28	5.25	4116.	36.75	1129.	3.53	19.	14896.	133.	2688.	12.41	29.	22736.	203.	1624.	19.09
26	6.25	4225.	40.625	1248.	4.1	21.5	14534.	139.75	2824.4	14.4	34.	22984.	221.	1768.	22.13
24	7.25	4176.	43.5	1336.	4.81	25.	14400.	150.	3031.56	16.9	39.	22464.	234.	1872.	25.98
22	8.5	4114.	46.75	1436.	5.725	30.5	14762.	167.75	3390.3	20.1	47.	22748.	258.5	2068.	30.91
20	10.375	4150.	51.875	1591.	6.93	37.	14800.	185.	3738.9	24.33	57.	22860.	285.	2280.	37.41
18	12.75	4131.	57.375	1762.	8.55	45.5	14742.	204.75	4138.1	30.03	70.	22680.	315.	2520.	46.18
16	16.25	4160.	65.	1997.	10.82	57.5	14720.	230.	4648.4	38.01	88.	22528.	352.	2816.	58.45
15						65.5	14737.	245.6	4964.3	43.25					
14	21.	4116.	73.5	2258.	14.13	72.5	14210.	253.75	5128.3	49.65					
Average		4150.					14624.9					22683.2			

American Machinist

TABLE 5. EXPERIMENTS WITH BEAMS SUPPORTED AT BOTH ENDS AND LOADED AT THE CENTER.

Thus, for a beam held at one end, loaded at the other and also at another point, Fig. 13, we may have the relation:

$$P L^2 + P_1 L_1^2 = \text{constant.} \qquad (21)$$

which is verified by very easily made experiments.

This being true for two forces is also true for any number of forces, and we have:

$$[p_1 l_1^2 + p_2 l_2^2 + p_3 l_3^2 + \ldots + p_n l_n^2] = \text{constant.} \qquad (22)$$

For a beam uniformly loaded $p_1 = p_2 = p_3 = \ldots p_n = p$ = pressure per unit of length, whence

$$p (l_1^2 + l_2^2 + l_3^2 + \ldots + l_n^2) = \text{constant.}$$

But the loads p_1, p_2, p_3, etc., being equally spaced if l is the distance between any two loads, we have:

$$p [l^2 + (2l)^2 + (3l)^2 + \ldots + (nl)^2] = \text{constant,}$$

or

$$p l^2 (1 + 2^2 + 3^2 + \ldots + n^2) = \text{constant.}$$

The sum of the squares of the numbers from 1 to n, inclusive, is

$$\frac{n (n+1) (2n+1)}{1 \cdot 2 \cdot 3}$$

But l is the unit of length and $n = n$ units of length $= L$, hence:

$$\frac{p l}{6} (L+1) (2L+1) = \text{constant} = \frac{\pi^2}{4} E I. \qquad (23)$$

This cannot well be proven experimentally, because it would be difficult to so suspend the loads as to insure to the beam complete freedom to deviate or buckle laterally. But we will now analyze an experiment which completely proves the combination of the effects of forces.

A beam was tested in the manner shown by Fig. 14. It was supported at the ends and equally loaded at two points A and B equidistant from the center of the beam. These points were varied along the length, but always kept equidistant from the center, and the loads applied were always equal—that is $P = P_1$. The results are shown in table 8. Here the relation $P L^2 =$ constant does not exist. Instead, we have the bending moment $P L =$ constant. This at first seems to indicate a radical modification of the first law, but we will see presently that it confirms it remarkably.

The question is much simplified if the effect of one load is studied independently of the other. Therefore, we may decompose the problem into two parts, viz.:

1. *A beam of length* L *supported at the ends sustains a load* P *applied at any distance* l *from one end;*

2. *The beam sustains two equal loads* P *and* P_1 *equidistant from the center.*

CASE I, FIG. 15.

The reactions of the supports are p and p_1. The moments about B are $p l = p_1 l_1$. We now have the well-known relations:

$$p + p_1 = P; \qquad l + l_1 = L;$$

$$p = \frac{P l_1}{L} = \frac{P (L-l)}{L}; \quad p_1 = \frac{P l}{L}.$$

If the action of the force p was such as to cause the buckling of the part $B b$, we would have:

$$p l^2 = C = \frac{\pi^2}{4} E I; \ (C = \text{constant}).$$

But here to this action must be added that of force p_1. Thus we have $p l^2 + p_1 l_1^2 = C$. Replacing p and p_1 by their values as above, then:

$$\left(\frac{P l_1}{L} \times l^2\right) + \left(\frac{P l}{L} \times l_1^2\right) = C,$$

or

$$\frac{P}{L} (l_1 l^2 + l l_1^2) = C;$$

and finally after reduction:

$$P l l_1 = P (L-l) l = C. \qquad (24)$$

This can be demonstrated in another manner as follows: The actual moment at the middle of the beam due to force p is

$$p_2 \times \frac{L}{2} = p l.$$

In other words, the force p_2 is that which, acting at b, would produce about C a moment $p_2 \cdot \frac{L}{2}$, equivalent to the actual moment $p l$. We have then $p_2 = 2 p \frac{l}{L}$.

Similarly for p_1 the corresponding force p_3 would be

$$p_3 = \frac{2 p_1 l_1}{L}$$

The buckling of one-half of the beam would be due to the combined efforts of p_2 and p_3 acting upon a length $\frac{L}{2}$, therefore:

$$p_2 \left(\frac{L}{2}\right)^2 + p_3 \left(\frac{L}{2}\right)^2 = C,$$

or

$$\frac{2 p l}{L} \cdot \frac{L^2}{4} + \frac{2 p_1 l_1}{L} \cdot \frac{L^2}{4} = C.$$

Replacing p and p_1 by their values as before:

$$\left(\frac{2 P l l_1}{L^2}\right) \frac{L^2}{4} + \left(\frac{2 P l l_1}{L^2}\right) \frac{L^2}{4} = C.$$

Finally we have again $P l l_1 = C = \frac{\pi^2}{4} E I.$

If the load is applied at the middle of the beam, $l = l_1 = \frac{L}{2}$, therefore $P l l_1 = \frac{P L^2}{4} = C$; whence

$$P L^2 = 4 C = \pi^2 E I,$$

as found by the experiment.

CASE II, FIG. 14.

The reactions of the supports are:

at a,	at b,
p	p_1 . . . due to P,
p_1	p . . . due to P_1.

We have here also the known relations:

$$p + p_1 = P = P_1, \ l + l_1 = L,$$

$$p = \frac{P l_1}{L} = P\left(\frac{L-l}{L}\right), \ p_1 = \frac{P l}{L}$$

The bending moment about A or B: $(p + p_1)\ l = P l$ is maximum and constant from A to B. For instance, at C the moment is

$$2 \left(p_1 \cdot \frac{L}{2}\right) = P l.$$

The sum of the effects of the two forces P and P_1, causing the buckling of the beam, we must find as before:

$$2 \left(\frac{2 P}{L} \cdot \frac{L^2}{4}\right) = P L l = C = \frac{\pi^2}{4} E I.$$

$\left(\frac{2 P l}{L}\right)$ is the value of the force which would produce upon a length $\left(\frac{L}{2}\right)$ an effect equivalent to that due to the force P acting on a length l.

If we call P_0 the total load carried by the beam, then $P + P_1 = P_0$, and therefore

$$P L l = \frac{P_0}{2} L l = C.$$

When this load is applied at the center of the beam, $l = \frac{L}{2}$, whence

$$\frac{P_0}{2} L l = \frac{P_0 L^2}{4} = C, \qquad (25)$$

and we have as before

$$P_0 L^2 = 4 C = \pi^2 E I.$$

Thus we see that equation (25) explains the results obtained in the experiments. The bending moment was found to be constant, the equation shows, in effect, that $P l = C =$ constant.

COROLLARY, FIG. 16.

The beam sustains a load P_0 *uniformly distributed.*

In Case II we have considered one system of forces equidistant from the center of the beam, but for a beam uniformly loaded, the buckling is evidently due to the sum of the efforts of a great number of such systems. Consequently, if p is the load per unit of length, we may assume that the beam sustains a number of forces distant from one another a length l equal to the unit of length. Since two symmetrically applied forces, such as p_0, constitute a system, we must have:

$$\Sigma p_0 L l = C; \qquad (26)$$

or $p_0 L [l + 2l + 3l + \ldots + nl] = C.$

Hence $p_0 L l \left(\frac{n (n+1)}{2}\right) = C.$

But $p_0 = p$, $l = 1$, $nl = L$; therefore, the limit of the elastic equilibrium of a beam supported at the ends and uniformly loaded may be expressed by the equation:

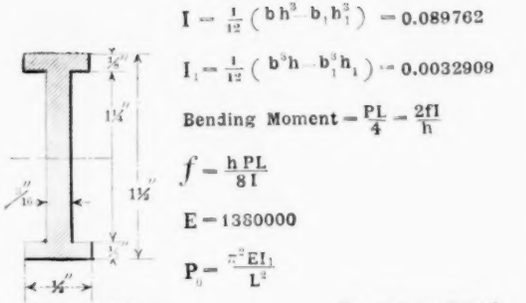
$$p L^2 \left(\frac{L+2}{2}\right) = 4 C = \pi^2 E I;$$

or, since $p l = P_0 =$ total load applied on the beam,

$$P_0 L \left(\frac{L+2}{2}\right) = \pi^2 E I. \qquad (27)$$

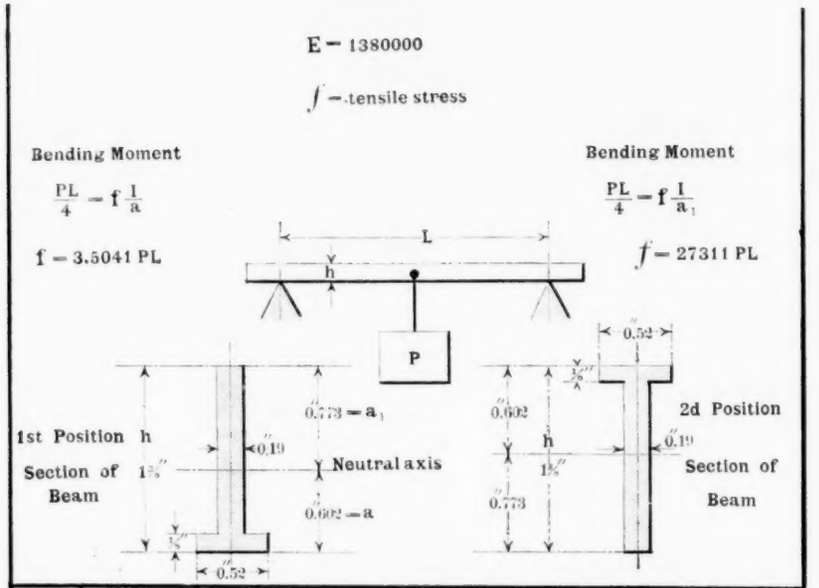
A great number of cases in which forces tend to destroy the elastic equilibrium of beams held or supported in various manners remain to be treated, but for the solution of our *simple problem* we must content ourselves with the few examples briefly analyzed in the present memoir. However, the writer is preparing a voluminous work in which the principal questions likely to be encountered in practice are given proper treatment.

Because the few tables given in this



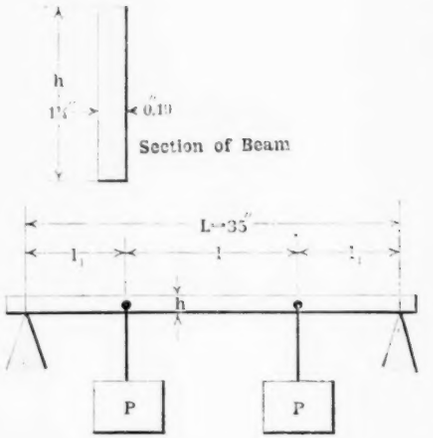
L	P	PL^2	$\frac{PL}{4}$	f	P_0
34	44.	50864.	374.	3124.9	38.77
32	49.	50176.	392.	3275.3	43.77
30	56.	50400.	420.	3509.3	49.80
28	64.	50176.	448.	3743.2	57.17
26	74.	50024.	481.	4018.9	66.30
24	88.	50688.	528.	4411.6	77.82
22	102.	49368.	561.	4687.3	92.61
Average		50242.3			

TABLE 6. EXPERIMENTS WITH A BUILT-UP I-BEAM.



L	P	PL^2	$\frac{PL}{4}$	f	P	PL^2	$\frac{PL}{4}$	f
34	27½	31790.	233.75	3276.	28½	32946.	242.25	2646.
32	30½	31232.	244.	3420.	34½	35328.	276.	3015.
30	34½	31050.	258.75	3627.	40	36000.	300.	3277.
28	37½	29400.	262.5	3679.	44½	34888.	311.5	3403.
26	41½	28054.	269.75	3781.	52½	35490.	341.25	3728.
24	48½	27936.	291.	4079.	56½	32544.	339.	3704.
22	55½	26862.	305.25	4278.	64½	31218.	354.75	3875.
20					81½	32600.	407.5	4452.
Average		29474.85				33876.75		

TABLE 7. EXPERIMENTS WITH A BUILT-UP T-BEAM.



l	l_1	P	Pl_1	Pl_1^2	Pl^2
22	6.5	7 1/16	46.718	303.67	3478.7
20	7.5	6 3/16	47.343	355.07	3595
18	8.5	5¼	46.75	397.37	1782
16	9.5	4 13/16	45.719	434.33	1908.9
14	10.5	4¼	45.937	482.34	877.47
Average			46.49.		

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TABLE 8. EXPERIMENTS WITH A BEAM CARRYING TWO LOADS.

memoir concern only beams of small section, the largest being 2x¼ inches, many readers may think that the whole proceeding is more of the nature of play than of serious study, and that the conditions dealt with are not those likely to be encountered in practice.

It should be remembered that from the start the object of the investigation was the discovery of the principle governing the case. The writer is confident that this object has been attained. By means of very simple apparatus, with specimen of diminutive sizes—permitting the selection of almost perfect material—requiring relatively small loads to cause distortion, many objectionable features were eliminated from the tests. For instance, the friction at the points of support of the beams was not of such importance as would have been the case with heavy loads causing the supports to indent the beams, and thus guide these in a certain direction, preventing them from twisting naturally (see experiments on T-beams); the smallness of the specimens and of the loads afforded easy handling of the objects and also—which is most important—a more complete ob-

servation of the phenomena taking place. Not in defence of the method employed by the writer, but simply to strengthen the confidence of the readers and of those who would like to verify the results given here, it may be said that the Science of the Resistance of Materials owes more to laboratory experiments on small scale than to those made on large specimen. Besides, although the beams employed were rather diminutive, it suffices to glance at the values of f given in the tables to be convinced that in many cases the breaking strength of the specimen was almost attained. (In several occasions f = nearly 5,000 pounds per square inch.)

Should subsequent tests undertaken by skillful experimenters upon specimen of various forms and composition prove the necessity of modifying by suitable coefficients the formulas advanced here, the fact remains patent that, in principle, there exist three principal laws governing the elastic equilibrium of solids. These laws, unknown until now, may be expressed thus:

First Law.—The load causing the buckling of a beam through flexure is inversely proportional to the square of the length upon which it acts directly.

Second Law.—The load is directly proportional to the cube of the thickness and to the depth of the solid or, generally, directly proportional to the moment of inertia of the section of the beam considered, taken in reference to an axis passing through the center of gravity of the section, parallelly to the direction of the load.

Third Law.—The total effect of one or several forces or of their components is equal to the algebraic sum of their individual effects.

(*To be continued.*)

Special Electric Hoist.

This hoist has been designed to operate in the narrow space between the ends of two traveling gantry cranes which serve the building sheds of a large shipbuilding company. This space is only 3 feet wide, and necessarily caused the adoption of some special features in the design, in order that no part of the hoist should project beyond this limit. The hoist runs lengthwise of the building and is supported from the roof trusses at a hight of 113 feet from the ground by a pair of Z-beams.

Eight supporting wheels run on the inside flanges of these beams and two guide wheels are arranged to bear on the webs of the beams in case there is any tendency for the trolley frame to get out of alinement. Two heavy pins are provided in the trolley frame and located slightly higher than the tread of the wheels, and which would come in contact with the flanges of the Z-beams if one of the supporting wheels should break, and thus prevent any danger of dropping the hoist and load.

The four wheels at the left in the cut are driven by an 8 horse-power Pawling & Harnischfeger motor seen in the center of the upper frame. This motor furnishes sufficient power for a traversing speed of 400 feet per minute under full load. The power is transmitted from the motor to the wheels through bevel gears.

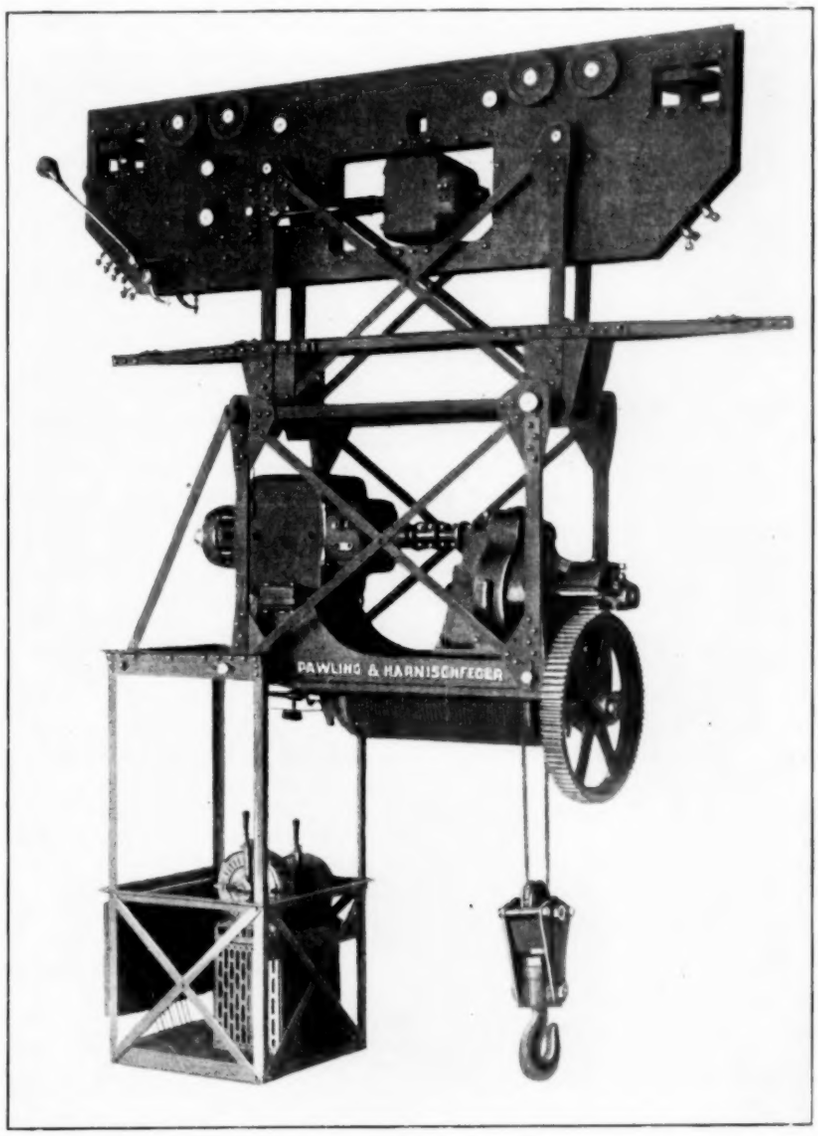
Suspended from the trolley frame by flexible joints is the structure carrying the hoisting drum, its 20 horse-power motor and the operator's cage. The speed reduction from the motor to the drum is by a train of spur gearing which is entirely enclosed, except the last slow-running pair. An automatic brake operates on the motor, the brake being applied more strongly as the hoisting current decreases, while a mechanical brake controls the speed in lowering.

A limit switch is provided which prevents over winding on account of the failure of the operator to cut off the current at the controller.

Current for the motors is taken off trolley wires suspended along the Z-beams on each side. One of the spring-operated trolley poles is seen at the left in the cut, the other being hidden by the frame. One trolley and wire carry the current from the dynamo, and the other the return current. The current is distributed from a switchboard placed outside the operator's cage, but yet within easy reach.

The hoisting speed varies from 120 feet per minute to 40 feet for light and heavy loads respectively. The capacity of the machine is 10,000 pounds, and its weight the same.

Pawling & Harnischfeger, Milwaukee, Wis., are the builders of the machine, including the motors and controllers.



SPECIAL 5-TON ELECTRIC HOIST MADE FOR THE NEW YORK SHIPBUILDING COMPANY BY PAWLING & HARNISCHFEGER.

Every week $20,000 worth of United States typewriters go to England, and though France claims their invention, none are manufactured there, most of those used being American.

Fixture for Forming Taper Tubes With Feed Motion for the Blanks.

BY MOSES G. WILDER.

To form in dies a taper tube from a punched blank is more difficult than to make a straight one, because the blank must be held in position endwise as well as sidewise. The fixture shown not only provides for this, but it also shows a novel form of feed motion. One of the difficulties of feeding a rapid-running press is that when the operator's fingers are moving to and from the dies in placing the blanks in position, a hasty or inaccurate movement may bring the fingers under the moving dies. The necessity of avoiding this danger limits the speed of the press and increases in proportion the cost of the work produced.

In the fixture shown the blanks are fed across the front of the press from left to right, and the operator is in no danger from the moving dies at any speed. Another advantage is the fact that the blank is placed accurately in position by the machine itself, and is held until the punch comes down in contact with it. Human fingers cannot do this with the same certainty, and therefore the work produced here is more perfect and uniform than if fed in any usual way by hand. The drawing is of a fixture adapted to a press which is not in the market. Some modifications of an ordinary press must therefore be made, including the designing of a cam which will feed at the proper time and with the right extent of movement.

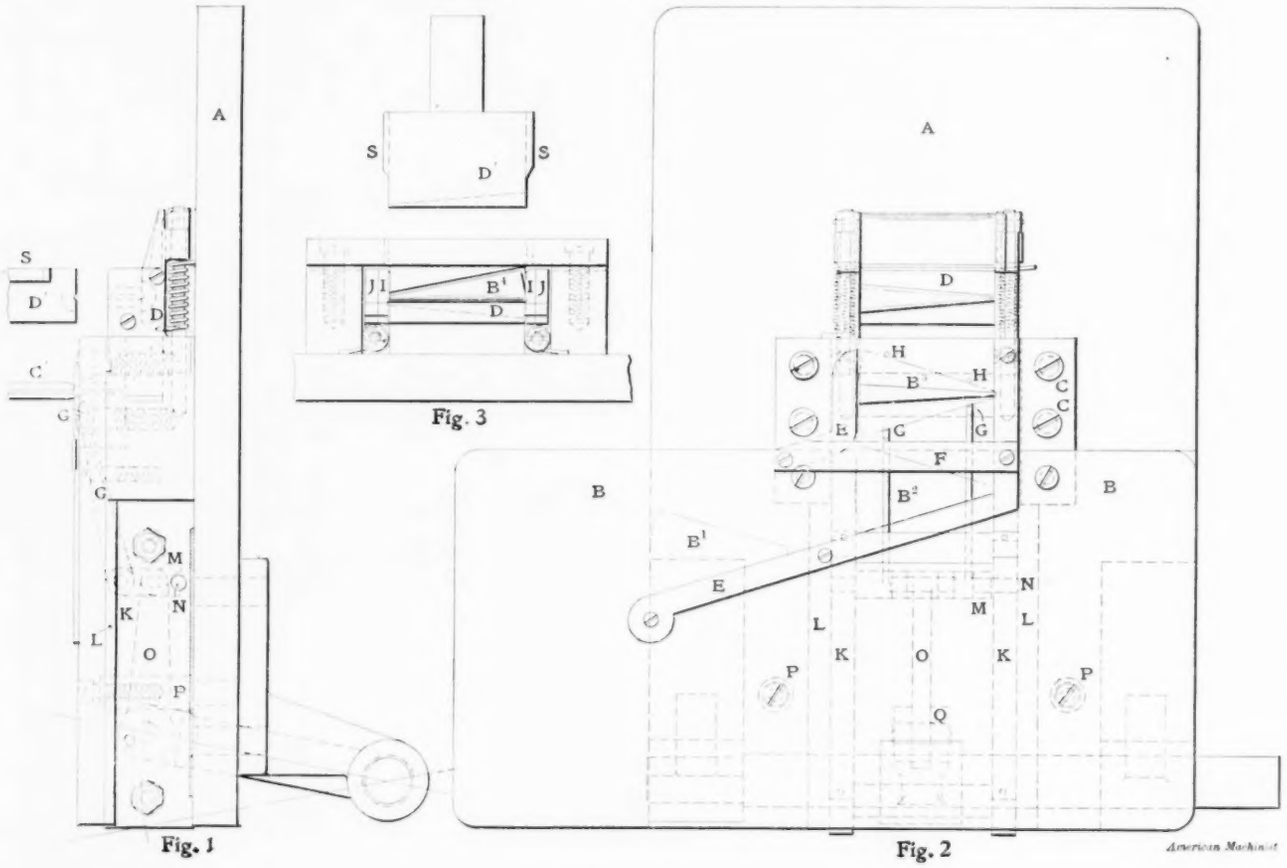
Fig. 1 is a side elevation of the entire fixture, Fig. 2 is a plan and Fig. 3 a partial elevation from the rear, showing the relation of the blank after it is bent into "U" form to the feeding mechanism and the lower forming die. In this view the upper forming die is in its highest position; and at the corresponding period in the revolution of the press the feed carriage is about to start with the blank to place it in position between the forming dies.

A is the die bed, holding forming dies *D D*, and also, upon a raised portion, are the drawing-through dies *C C* for bending the blank into "U" form. *B* is a raised platform or feeding table, its upper surface level with dies *C C*. *D D*[1] are forming dies to fit the finished tube; *E E*[1] guides or set-edges of steel to locate the blanks; *B*[1] *B*[2] *B*[3], blanks shown in dotted lines in successive positions; *F*, a steel plate bridge under which the blanks pass in feeding; *G G*, push-fingers, which push the blanks into position against stops and hold them until the punch comes into contact with the blank; *H H*, stop or set-pins; *I I*, plates of steel, grooved upon the face to fit the ends of the partly formed tube from the drawing-through dies and to face level with dies *C C*. *D D*[1] are forming dies, and *J J*, rocking carriers upon which plates *I I* are mounted. Springs of steel wire engage these carriers and give them an inward movement to cause a slight pressure of the plates against the ends of the forming dies, and to hold the partly formed tube firmly while carrying it from one die to the other.

When the upper forming die *D*[1] in its downward stroke reaches a position where the tube held between the plates is controlled by the die, the carriers and plates are pushed apart by projections *S S*, which are shown upon the upper die *D*[1] in Figs. 1 and 3. This releases the tube from the carriers.

K is the feed carriage, fitted to slide in and out between the top of the die bed and the under side of platform *B*. Cheeks *L L* are cast on the under side of platform *B*, and are fitted to guide the carriage sidewise. Two sheet steel springs are fitted as shoes under the carriage to cause a slight drag. This drag is a provision to ensure prompt up and down motion to the push-fingers as they move backward and forward with the carriage.

Q is an arm carried by a rock shaft mounted in bearings attached to the under side of the die bed. A cam (not shown) gives motion to this shaft and arm *Q* as the press revolves, moving the carriage backward and forward in proper time. Arm *Q* is connected to the carriage by a pitman, which is pivoted at one end to the arm and at the other to downwardly projecting short arms of the rocker that car-



FORMING TAPER TUBES.

ries the push-fingers *G G*. A limiting pin extends inward from the side of the carriage, and, passing through a jaw in one of these arms, controls and limits the up and down movement of the push-fingers.

The operator, holding a lot of blanks in the left hand, places them, sharp side down, upon the platform as at B^1. With a quick movement of right hand they are pushed successively under the bridge *F* into position B^2. The fingers rest lightly upon the blank until the push-fingers begin to move it away, when the right hand swings back to position B^1 to repeat the motion of feeding the blank. The feed carriage, operated by the cam and arm *Q*, moves forward; the push-fingers, which are behind the blank in position B^2, rise and engage the blank, pushing it forward into position B^3 as the punch descends. This forward motion of the blank continues until the drawing punch is almost or quite in contact with it. This ensures the accurate placing of the blank preparatory to the bending operation.

The blank at B^3 is pushed down between the bending dies *C C* and between the grooved faces of carrier plates *I I*, and does not move forward toward the forming dies *D* D^1 until the beginning of the next stroke. It moves forward soon enough, however, to be in position when the dies can act upon it, and, as previously explained, remains in the forming dies until in the next following stroke it is thrown out of die *D*. After the carriers are pushed back by the projections upon die D^1 the carriage and carrier plates *I I* move quickly into position to receive the next blank from the bending dies, which is pushed down between them as before.

As the carrier plates move forward with the bent blank the sloping ends of the plates, which are extended forward for that purpose, pass under the ends of the finished tube, which at this time lies in die D, lift this tube out of the die and push it forward out of the way. To provide for this being done with certainty, the taper tube blank is made a trifle longer than the forming dies; it is then placed so that the ends project equally over the ends of the dies. This excess of total length need not be over two or three hundredths of an inch, as the lifting edges of plates *I I* can be quite in contact with the die *D*.

If this fixtures and its dies are carefully made and fitted there should be no difficulty in forming from perfect blanks of I-C tin 100 to 150 tubes per minute. They should be airtight and perfectly round and true.

Curves of Progress.*

BY SIDNEY GRAVES COON.

Among the almost infinite number of curves which may be drawn, with time as one co-ordinate, nearly all of which would represent human progress in one form or another, a few may be selected as of primary interest to the engineer, as portraying progress along the particular lines to which his energies are devoted. Curves of this sort may be divided into a number of groups or classes, some depicting advances in details or processes connected with engineering enterprises, others showing the increase in the use of engineering material of various kinds. Still others show the trend of progress in lines more or less closely allied with those of more strictly engineering interest. A few such curves have been drawn and are here presented as representative of the results which may be obtained from the study of the progress of the nation in engineering and other lines.

Fig. 1 shows four curves representing the advances of about a century in certain details connected with steam engine practice. The duties of steam pumping engines from 1770 to 1890 show a continued and consistent increase, giving a smooth curve. Its convexity upwards, however, being due to a steady decrease in its slope, is indicative of a negative acceleration. The curve seems to be approaching an asymptote located somewhere in the neighborhood of 140,000,000 foot-pounds per 100 pounds of coal. With a calorific value of 14,500 British thermal units per pound of coal and a mechanical equivalent of 778 foot-pounds per British thermal unit, 100 pounds of coal has a total available energy of 1,128,000,000 foot-pounds. Our asymptotic line, therefore, would represen' a total efficiency of 12.4 per cent. One century ago, with a duty of 57,000,000, efficiency was 5.05 per cent.; while in 1770 it was only 0.62 per cent.

The economy curve shows a constant and steady decrease in the coal consumption of representative engines throughout the century. No point of inflection has yet appeared, the curve continuing to drop off rapidly, and, so far, with continued acceleration. Such a point of reversed curvature must soon be reached, however, as the economy more and more nearly approaches that of the ideal engine.

The curve of steam pressures used shows the gradually and (later) rapidly increasing pressures representing average practice. The tendency at the end of the nineteenth century is clearly shown by the steepness of the curve at that point to be towards continually increasing pressures for some time to come. Such a feature means always a higher mean effective pressure, with its corollary of a much smaller engine to perform any given work, or more work from a given engine. It is established mathematically that an increase of steam pressures from 100 pounds per square inch to 1,000 pounds would increase the efficiency of the engine 50 per cent., or, in other words, would reduce the required amount of heat per indicated horse-power per hour to two-thirds its former value, with a corresponding reduction in the consumption of coal.

The power per unit of weight represented by practice in naval vessels affords an interesting index of progress along constructional lines. The curve shows a continual rise from 1.4 horse-power per ton in 1833 to about 11 to-day. The convexity of the curve is here indicative of a gradually decreasing acceleration in the reduction of weights, though nothing approaching asymptotic symptoms has yet developed.

The curves in Fig. 2 show the total power of prime movers available in the United States at various periods in our history, and the divisions and classifications under which this power falls. (Hydraulic power is not included owing to lack of data.) It will be noticed that every one of these curves has a convexity, as viewed from above, showing accelerated growth in every instance.

The total power is seen to have augmented enormously. The curve is now very

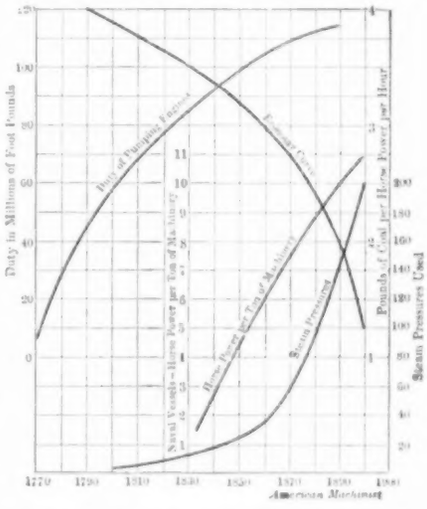


FIG. 1. CURVES OF STEAM ENGINE PROGRESS.

steep, and gives no evidence of abatement. In seventy years this has increased from 1,900,000 horse-power to 36,000,000 horse-power, a gain of 1,800 per cent., while population has increased only 493 per cent. The horse-power per capita in 1830 was 0.15; in 1900 it was 0.47. On analysis this tremendous extension of power is found to be very largely due to the rapid increase in steam power, which is adding up at a continually increasing rate. In 1830 it is estimated that the total steam power in the United States was represented by about 200,000 horse-power; to-day it is above 20,000,000, or an increase of upwards of 10,000 per cent. Then, there was one steam horse-power to sixty-four people; now, one for less than four people.

Steam power may be subdivided into three main heads: stationary engines, locomotives, and marine engines. Of these the locomotive is responsible for about 60 per cent. of the total steam power, this ratio having been nearly constant during the past half-century. Since 1880 the power of our locomotives has much more than

*Sibley Journal.

doubled, increasing 128 per cent., while population has gained only 52 per cent. There are no signs of a let-up in this progress. Stationary and marine engines, while showing a lower rate of increase than locomotives, are yet gaining on population, giving more than 100 per cent. gain in the last twenty years.

Hand power, which in 1830 was about even with steam power, keeps even pace with population, being now only 14 per cent. of the total steam power. Horse power increases rather faster than population. The curve at present is very near a straight line, indicating a continued increase without acceleration.

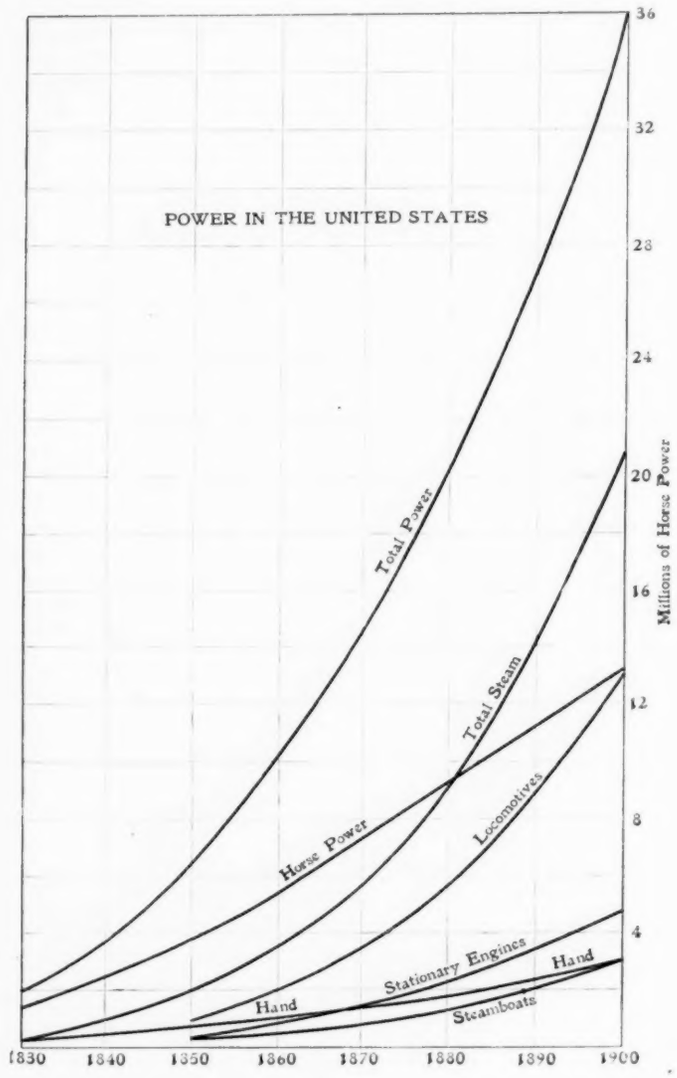


FIG. 2. POWER PROGRESS.

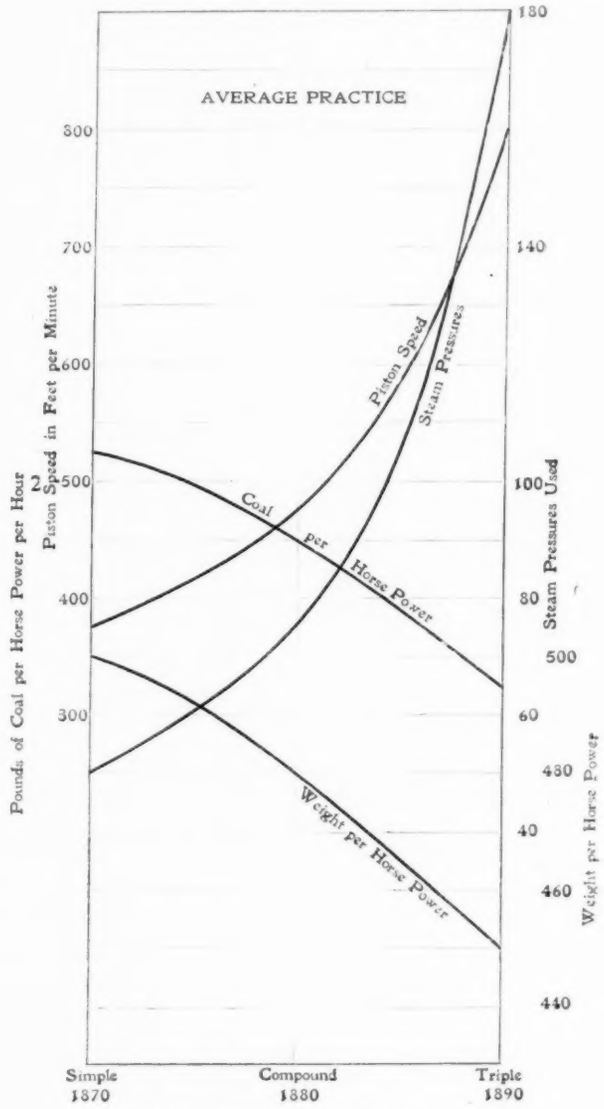


FIG. 3. PROGRESS IN ECONOMY.

Fig. 3 shows the general effects obtained by the introduction of the compound and triple-expansion engines. The high-water mark of the simple engine was reached about 1870; in 1880 the compound was in high favor, while by 1890 the triple-expansion engine was well established. The steam pressure curve is seen to have gone up rapidly, and the recent advent of quadruple-expansion engines in marine practice has shoved it up still higher. The weight of engine per horse-power is falling off, with increase in the stages of expansion; decreased size for a given power under high-pressure steam is partly reponsible for this, as is also the advance in materials of construction and methods of manufacture. The increasing complexity of design militates against this downward tendency and the necessary thickening of cylinder walls and steam passages incident to the use of higher pressures has the same effect. The decreased cylinder condensation, due to sub-dividing the fall in temperature between initial steam and exhaust into a number of stages, has effected a saving in coal, the results of which are well shown in the curve. With increasing steam pressures, the speeds of revolution have increased and the piston speed has rapidly gone up. It is now much more than double its value of a century ago and is apparently destined to increase for some time to come. Consequent upon this feature has occurred part of the reduction of weight per unit of power previously considered.

As already mentioned, these cases might be multiplied indefinitely and a vast amount of data collected into the form of curves depicting the varying relations of progress with time. Enough has been presented, however, to show the enormous advances engineering science has made in this country during the past century, and particularly during the latter part thereof.

Table for Finding the Thickness of Boiler Plates.

BY GEO. F. SUMMERS.

Having to pass upon the thickness of boiler plates for the Schenectady Locomotive Works, and having devised several schemes for expediting the work, I have finally settled down to the use of the accompanying table, which has been in daily use for six months and has proven very satisfactory.

At the intersection of the line containing the diameter of the shell and of the column containing the boiler pressure will be found the exact thickness of the plate, and

Inside Diameter of Boiler in Inches	Ultimate Strength = 55000. Lbs. per Sq. In. Seam = 75% for Sextuple Riveted Seam. Factor of Safety = 3.97									Equivalent to Ultimate Strength = 55000. Seam = 85%. Factor of Safety = 4.5							Inside Diameter of Boiler in Inches
	Boiler Pressure in Lbs. per Sq. Inch																
	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	
48	.231	.254	.277	.300	.323	.347	.370	.393	.416	.439	.462	.485	.508	.531	.554	.578	48
49	.236	.259	.283	.307	.330	.354	.377	.401	.424	.448	.472	.495	.519	.542	.566	.590	49
50	.241	.265	.289	.313	.337	.361	.385	.409	.433	.457	.481	.505	.529	.553	.578	.602	50
51	.245	.270	.295	.319	.344	.368	.393	.417	.442	.466	.491	.515	.540	.565	.589	.614	51
52	.250	.275	.300	.325	.350	.375	.400	.425	.450	.476	.501	.526	.551	.576	.601	.626	52
53	.255	.281	.306	.332	.357	.383	.408	.434	.459	.485	.510	.536	.561	.587	.612	.638	53
54	.260	.286	.312	.338	.364	.390	.416	.442	.468	.494	.520	.546	.572	.598	.624	.650	54
55	.265	.291	.318	.344	.371	.397	.424	.450	.476	.503	.529	.556	.582	.609	.635	.662	55
56	.270	.296	.323	.350	.377	.404	.431	.458	.485	.512	.539	.566	.593	.620	.647	.674	56
57	.274	.302	.329	.357	.384	.412	.439	.466	.494	.521	.549	.576	.604	.631	.658	.686	57
58	.279	.307	.335	.363	.391	.419	.447	.475	.502	.530	.558	.586	.614	.642	.670	.698	58
59	.284	.312	.341	.369	.398	.426	.454	.483	.511	.540	.568	.596	.625	.653	.682	.710	59
60	.289	.318	.347	.375	.404	.433	.462	.491	.520	.549	.578	.606	.635	.664	.693	.722	60
61	.294	.323	.352	.382	.411	.440	.470	.499	.528	.558	.587	.617	.646	.675	.705	.734	61
62	.298	.328	.358	.388	.418	.448	.477	.507	.537	.567	.597	.627	.656	.686	.716	.746	62
63	.303	.334	.364	.394	.424	.455	.485	.515	.546	.576	.606	.637	.667	.697	.728	.758	63
64	.308	.339	.370	.400	.431	.462	.493	.524	.554	.585	.616	.647	.678	.708	.739	.770	64
65	.313	.344	.375	.407	.438	.469	.501	.532	.563	.594	.626	.657	.688	.720	.751	.782	65
66	.318	.350	.382	.414	.445	.477	.508	.541	.572	.604	.636	.668	.699	.731	.762	.794	66
67	.322	.355	.387	.418	.451	.484	.516	.548	.580	.611	.644	.677	.709	.741	.774	.806	67
68	.327	.360	.393	.426	.467	.491	.524	.556	.588	.622	.654	.686	.720	.753	.785	.818	68
69	.332	.365	.398	.432	.461	.497	.531	.564	.596	.631	.664	.696	.730	.763	.796	.830	69
70	.337	.371	.404	.438	.472	.506	.539	.574	.606	.641	.675	.707	.741	.775	.808	.842	70
71	.341	.375	.408	.444	.477	.511	.546	.580	.614	.647	.682	.716	.750	.784	.819	.854	71
72	.347	.382	.417	.451	.486	.520	.555	.590	.624	.660	.694	.727	.764	.797	.832	.866	72
73	.351	.386	.421	.456	.491	.526	.562	.596	.632	.666	.702	.736	.772	.806	.842	.878	73
74	.356	.392	.427	.463	.497	.534	.569	.605	.641	.675	.710	.747	.783	.818	.854	.890	74
75	.360	.396	.432	.468	.504	.540	.576	.611	.648	.684	.720	.756	.791	.828	.864	.902	75
76	.366	.403	.439	.476	.512	.549	.585	.621	.659	.695	.731	.768	.804	.841	.876	.914	76
77	.371	.408	.445	.482	.519	.556	.593	.630	.616	.705	.742	.779	.816	.854	.890	.926	77
78	.375	.413	.450	.488	.525	.562	.600	.636	.675	.712	.750	.787	.825	.862	.900	.938	78
79	.380	.418	.456	.494	.532	.570	.607	.646	.684	.721	.760	.796	.836	.874	.912	.951	79
80	.385	.424	.462	.501	.539	.527	.616	.654	.692	.731	.770	.808	.846	.885	.924	.963	80
81	.390	.428	.467	.507	.546	.584	.624	.662	.701	.741	.780	.818	.856	.896	.936	.975	81
82	.395	.434	.474	.514	.552	.592	.632	.672	.711	.751	.790	.830	.868	.908	.948	.987	82
83	.399	.438	.478	.519	.557	.599	.638	.677	.718	.758	.797	.838	.878	.917	.957	.999	83
84	.404	.445	.486	.526	.566	.606	.646	.687	.727	.767	.807	.850	.890	.930	.970	1.011	84
85	.409	.450	.492	.532	.573	.614	.654	.696	.737	.777	.816	.859	.900	.940	.981	1.023	85
86	.414	.456	.497	.538	.580	.622	.661	.704	.746	.787	.828	.870	.910	.952	.993	1.035	86

THICKNESS OF BOILER PLATES IN INCHES.

American Machinist

by following out the zigzag lines the nearest thicker commercial plate will be found in the margin.

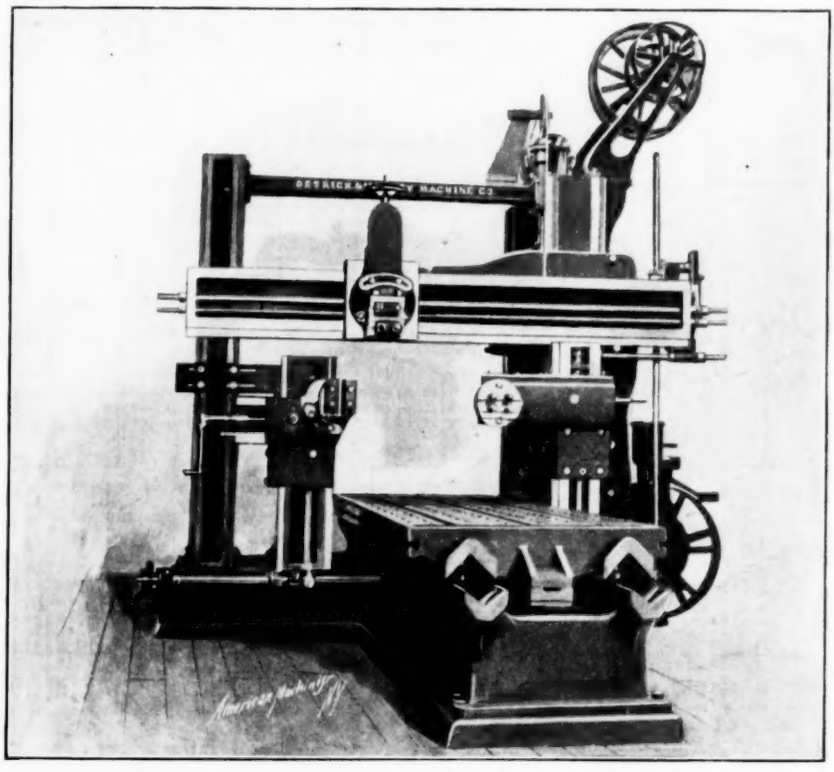
As the next thicker plate is always used the factor of safety given at the top will be understood to be the minimum factor, which is somewhat exceeded in most cases. The entry at the top and right is to be understood as meaning that with the same strength of plate, but with a seam having an efficiency of 85 per cent., the minimum factor of safety becomes 4.5.

Open Side Extension Planer for Locomotive Cylinders.

This planer is a modification of the regular open side planer and is intended for planing the frame seats, saddle joints and steam chest seats on all sizes of locomotive cylinders between 36 and 20 inches. The special end to be attained was to enable these surfaces to be finished at one chucking instead of the two or three that would be necessary if the work was done in the ordinary manner.

The outline drawing, Fig. 2, shows the position of the cylinder on the platen and the location of the surfaces to be finished.

The following particulars as to dimensions, etc., are furnished by the builders, the Detrick & Harvey Machine Company, Baltimore, Md.: Between main housings, 7 feet 3 inches; under cross-rail, 6 feet; maximum sized cylinder, 36 inches, low-pressure compound; steam chest seat, 36 inches planing width; saddle joint, 45 inches planing width; frame seats, 4½x5 inches; head on cross-rail, 7 feet 3 inches horizontal adjustment, 1 foot 3 inches vertical adjustment (by hand or power). Head on main housing for planing lower frame seat and center casting has 12 inches horizontal adjustment (by hand), 51 inches vertical adjustment (by hand or power). Tool-post can swivel in full circle. Head on intermediate housing for planing upper frame seat and steam chest seat has 8 inches horizontal adjustment (by hand), 36 inches vertical adjustment (by hand or power).



SPECIAL MACHINE FOR PLANING COMPOUND LOCOMOTIVE CYLINDERS AT ONE CHUCKING.

Echoes From the Oil Country.

FUN AT THE SAWMILL.

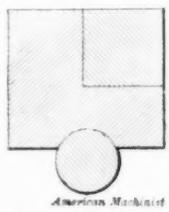
It was early spring, with the snow gone except in the sheltered valleys and in the big woods, when I got a call to go up the river to meet a man who would take me out to the mill where the engine needed some repairs. I was to go up on the morning train and was expected to get the night train back, waiting at the hotel at the station if I was there ahead of our patron. Although the train did not set me down until a little after 9 oclock, I had to wait quite a time before the buggy came for me, and I had grown quite impatient, as I did not want to stay in the woods all night, for if I did it would be afternoon the next day before I could get back to the shop. When finally the man did come he excused himself for being so late by saying that he had to wait for daylight before daring to try to get out of the woods. I thought the excuse rather a lame one just then, and his remark that the road was "pretty bad" didn't seem to add much to its force.

However, we started off, and after going about a mile turned off the main road into a hollow up Tubb run. In a few minutes we were among the trees and began to strike ice and snow. One minute the buggy would be up sideways, then we would drop into a hole and the axles would scrape on the ice between the wheels. Sometimes the horse had his front legs on one side of a ridge of ice and his hind legs on the other side and sometimes he would straddle it. By way of variety we would strike a strip of corduroy or a drift so deep that we would meander around off the road among the stumps and rocks for a ways. After the buggy sliding across a smooth place and bringing up by having the wheels on one side drop through some thin ice and nearly land us on the horse, I remarked that I thought this about the worst road I had ever seen.

"Well," said my friend, slowly, as though he was trying to remember the really bad roads he knew and didn't wish to misrepresent them, "'taint just as smooth as it might be right here, and it gets pretty blamed rough up ahead aways."

I remembered that my life insurance did not give anything for time lost through accidents, and I got right out and walked and studied mechanics, viewing the way the parts of that buggy squirmed and twisted. I had often heard that a vehicle for a rough country should be loose jointed, so as not to strain itself going over uneven ground, and one old job hand used to try to impress it on me that in fixing up machinery I should always keep the same idea in view. Other men used to laugh and say that was just an excuse for poor work. Watching that buggy brought this back to mind. I do not believe a new buggy would have stood the racket and gotten through whole. My friend had to get out and lift it around and out of holes and over stumps and across logs until we got over the bad spot.

At the mill I found they had started to take the piston head out, as they wanted the cross-head babbitted, and they thought the piston rings must be broken from the sound they made in stopping, and had taken the cylinder head off and started to unscrew the rod from the crosshead. After getting it about halfway out they had pulled the engine around until the rings fell into the port, and there they stuck fast and there I found them.



SECTION OF DUNBAR PACKING.

The head was a solid one (one piece, that is) with ring grooves cut in. The ports were long and narrow, running more than one-third of the way around the bore of the cylinder. The valve was short and the cylinder long, so the ports were long

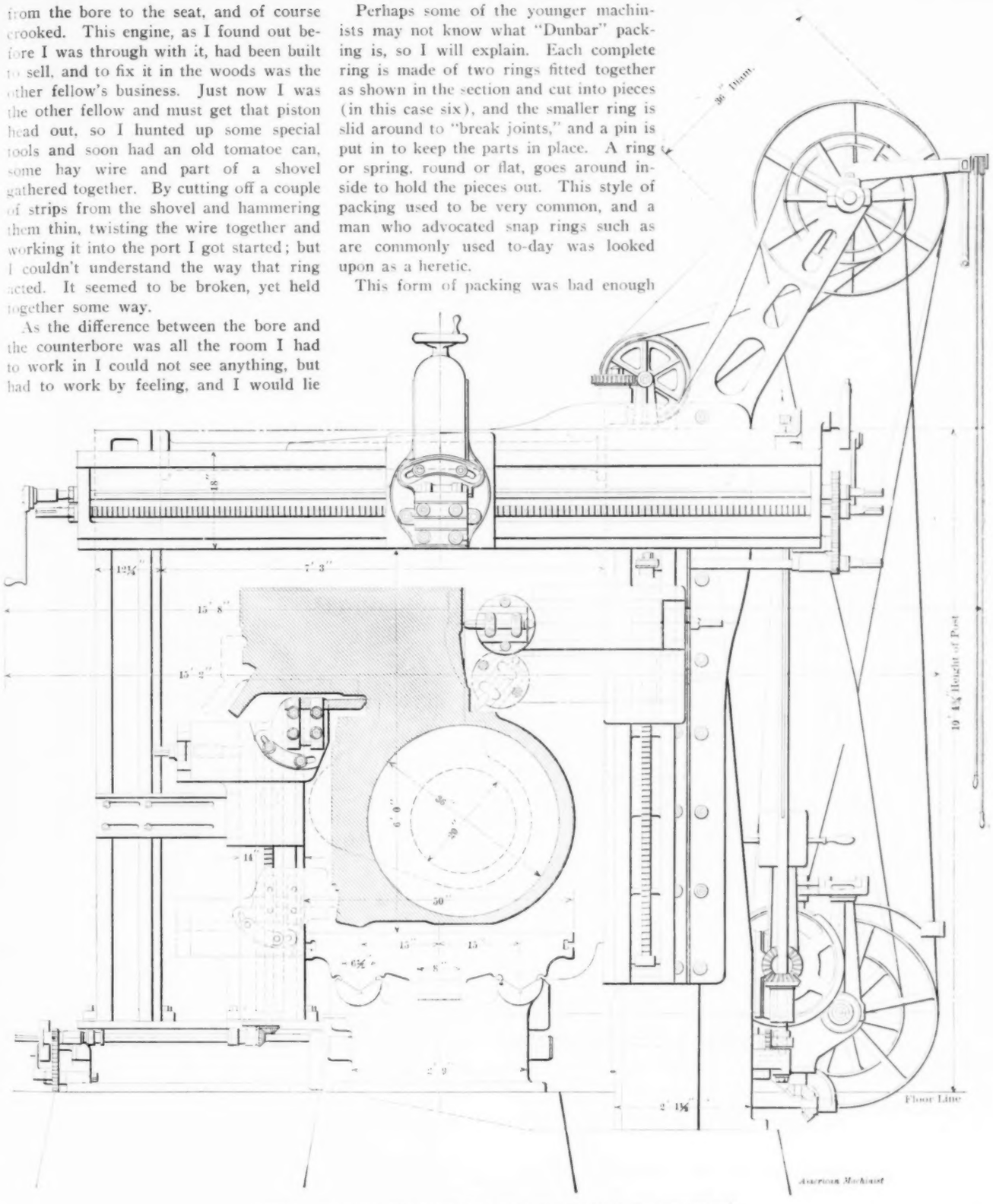
from the bore to the seat, and of course crooked. This engine, as I found out before I was through with it, had been built to sell, and to fix it in the woods was the other fellow's business. Just now I was the other fellow and must get that piston head out, so I hunted up some special tools and soon had an old tomatoe can, some hay wire and part of a shovel gathered together. By cutting off a couple of strips from the shovel and hammering them thin, twisting the wire together and working it into the port I got started; but I couldn't understand the way that ring acted. It seemed to be broken, yet held together some way.

As the difference between the bore and the counterbore was all the room I had to work in I could not see anything, but had to work by feeling, and I would lie down a while and then sit down and try it. Fortunately, sawdust is soft and clean. The thoughts of that road kept me going when I would lose my hold on the ring, and finally I got it out, and could hardly believe my eyes that some brilliant genius had put "Dunbar" packing into a one-piece piston head, and that head to work in a cylinder with ports like an alligator.

Perhaps some of the younger machinists may not know what "Dunbar" packing is, so I will explain. Each complete ring is made of two rings fitted together as shown in the section and cut into pieces (in this case six), and the smaller ring is slid around to "break joints," and a pin is put in to keep the parts in place. A ring or spring, round or flat, goes around inside to hold the pieces out. This style of packing used to be very common, and a man who advocated snap rings such as are commonly used to-day was looked upon as a heretic.

This form of packing was bad enough to handle in the woods, with cold hands, when it was in a built-up head with junk ring and follower, as one usually wished he had just one more hand to help hold some of the loose pieces while he got the spring in place. Two things were in my favor, though. They had been completely stuck, and I was getting paid instead of having to pay the bill. I owe a vote of thanks to some poor designers for the work they have given me. It took several tin cans and the balance of the shovel cut into strips to get those pieces engineered past the port when I got to putting the head in again, but as I knew what I had, it was then largely a matter of care and patience.

I found I was not through with all my



SPECIAL PLANING MACHINE FOR COMPOUND LOCOMOTIVE CYLINDERS.

fun yet, as I had the cross-head to babbitt, and a heavy, misty fog had come down on us that settled in a heavy dew, making everything wet as soon as wiped off, as we were in a shed without sides we could not shut it out. I inquired for rosin, but was told they hadn't any, and I began wondering how pitch would work instead, when I happened to remember seeing a fiddle when in at dinner and sent a man to find the owner and get the rosin he used for his bow. It wasn't a very big piece, but was the best I could do, so I powdered it and dried off the guides and cross-head the best I could and rubbed it on, saving a little to sprinkle in the holes before pouring. It had begun to rain hard and get very dark—too dark, it seemed to me, even for a storm in the woods. As I was leaning over the job, mudding up, the rain began to come through the roof on to my back and to go down my neck, and I found if I moved it would strike the cross-head. The men were coming in from the woods and reported a terrific storm coming over the river. One man got an umbrella and held over me, another lighted a lantern, while a third watched the babbitt. The wind was blowing a hurricane, bringing with it a blinding snowstorm and also terrific thunder and lightning. I grabbed the ladle with many misgivings, and telling the men to look out for their faces, as things were likely to fly, I poured that cross-head without any run-out or blow. We then gathered over by the boiler, where we might have it to help stop a tree in case one came down on the mill. The lightning struck several times near the mill and gave me some uneasiness about being near the boiler, but there was no other shelter, and I kept on the lee side. The boarding-house was a light frame affair that was not as safe as the mill. Altogether it was the wildest scene I had ever witnessed, getting so dark that the lantern was needed to move around with, then would come the blinding flashes of lightning that made the falling snow and tossing trees look ghastly; this was between 2 and 3 o'clock in the afternoon. It was soon over, and I finished up the cross-head, connected up while the boiler was fired, set the valve and tested her in time for supper.

After supper I was taken up a path, while three men went with a horse and buggy some round-about way to get up on to the road. The two extra men were needed to lift the buggy over logs and rocks, and they made good their claim to the mill owner that they could get up to the road, as did the driver of the rig that he could get me to town in time for the down-river train. This they called the hill road, and it was several miles farther around to get to town. I did not think we had time enough, but the driver earnestly assured me that he knew the road well and would either disable the horse and smash the buggy or get me there in time, and somehow this just seemed in keeping with the rest of the day, which I look back on as one of the wildest in my experience as a machinist. W. OSBORNE.

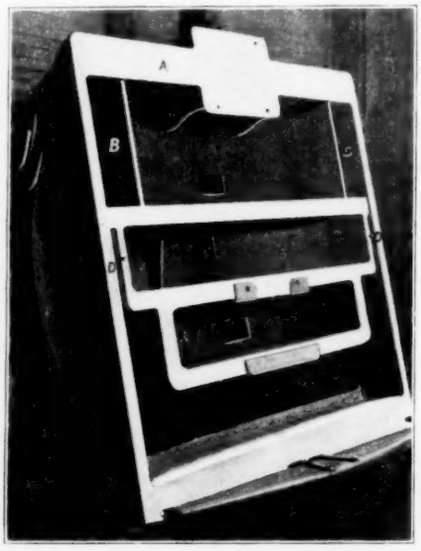


FIG. 1. A SAWMILL BED CASTING.

Molding a Sawmill Bed.

BY R. H. PALMER.

The casting to be made, or one very nearly the same, is shown in the half-tone, Fig. 1. It is molded or bedded into the floor, and the mold is built on planks laid on binders across the bottom of the pit, as indicated in Fig. 2. Sand is rammed over the planks, and a cinder bed *A*, Fig. 3, is put on each side of the part of the pattern called the wheel-house, with a pipe *B* to carry off the gas. This wheel-house part of the pattern, *X*, Fig. 3, is now located and sand and facing are rammed around it. Parts *H* and *D* are screwed to framework *C*, which has holes, not shown, to receive dowel pins on the pieces. The whole is now rammed up to nearly the top of these parts, when the framework *C* is removed, and the bed is made to receive the main part of the pattern. The whole is given a good venting down to the cinder bed, and a bed is made by use of a strike and pounding down, as molders term it. Pattern *B*, Fig. 2, is now dropped into position, being guided by dowel pins on the parts already bedded in. Weights are placed on it and it is rammed around, and

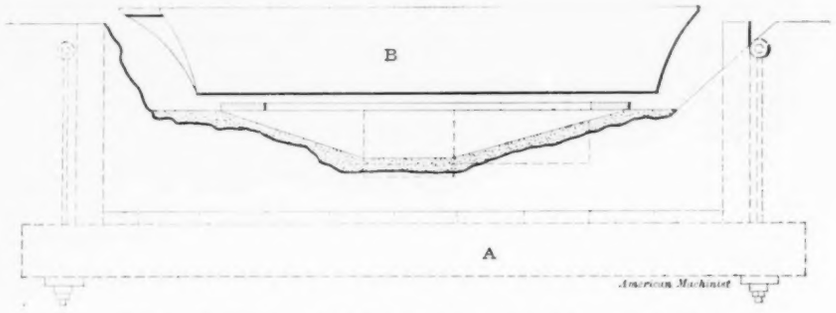


FIG. 2. ELEVATIONS AND VERTICAL SECTION OF PART OF MOLD.

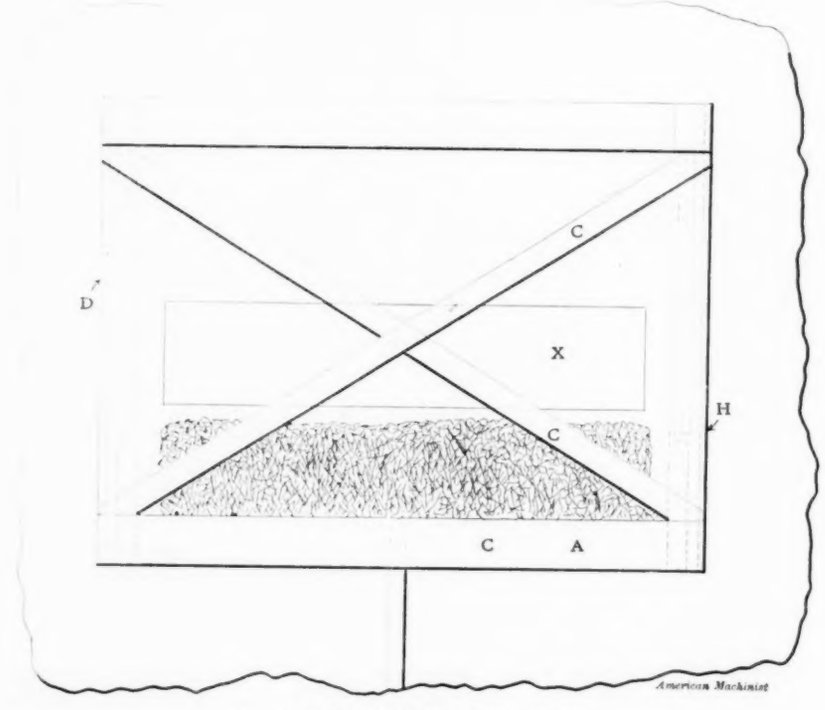


FIG. 3. PLAN OF MOLD PARTLY MADE.

provision is made for the iron to enter the mold through gate cores placed on the end of the pattern opposite each rib running lengthways down near the bottom of part *B*, or back of the section in Fig. 4, and so that the iron will enter where ribs are shown about as high as *Z*.

Sand being rammed to the top and the joint made, the inside is next rammed up. To form flange *Y* cores *A* are used. The pocket is rammed up, being provided with a cinder pocket. Sand is placed on the face of the pattern, and anchors *C* and *D* are rapped down. They have long eye-bolts extending above the cope. After ramming them partly up they are well vented and pockets of cinders are put in at *V V*, having gates to bring the vent to the top and connect with one through the cope.

All being rammed up, the cope is placed and staked, gate-sticks are set, etc. When rammed up some bars of shafting are run through the eyes of the anchor bolts, as *E*, and wedges are inserted under *E* and over iron bars *F*. The cope is hoisted off and swung to one side. As the inside *X X* of the wheel-house is made by a core, pockets *V V* are hoisted off with the cope. *M* is left when the pattern is drawn.

In Fig. 4 I have imagined the casting, Fig. 1, cut through from side to side at *A*. It will be seen that there are pockets *B* and C, which are made with dry sand cores. The flanges *O*, Fig. 4, are drawn inward. The binders are hemlock timber, some 12 inches deep and 10 inches wide, and in the above case heavy weights *K K* were used in addition to the binders.

I have tried to show in Fig. 4 the general arrangement for securing the mold and also for pouring. The casting was made at the foundry of Clark Bros., Belmont, N. Y., to whose courtesy I am indebted.

Fig. 5 shows a scene in the same foundry, the mold in the foreground being for a sawmill base, though of a somewhat different pattern from the casting shown in Fig. 1. Save for some difference in securing the inside to accommodate the other peculiarities of the piece, the general principles of molding the two are alike, as the same cope and general rigging answers for both; hence by reference to Fig. 3 it can be seen how the cores forming the slots in the casting at *D*, Fig. 1, are secured at *D*, in Fig. 5, and the core forming the inside of wheel-house is seen in position in Fig. 5 as it would be were the style of casting the same, the difference being in size and in certain bracing or ribbing of the casting.

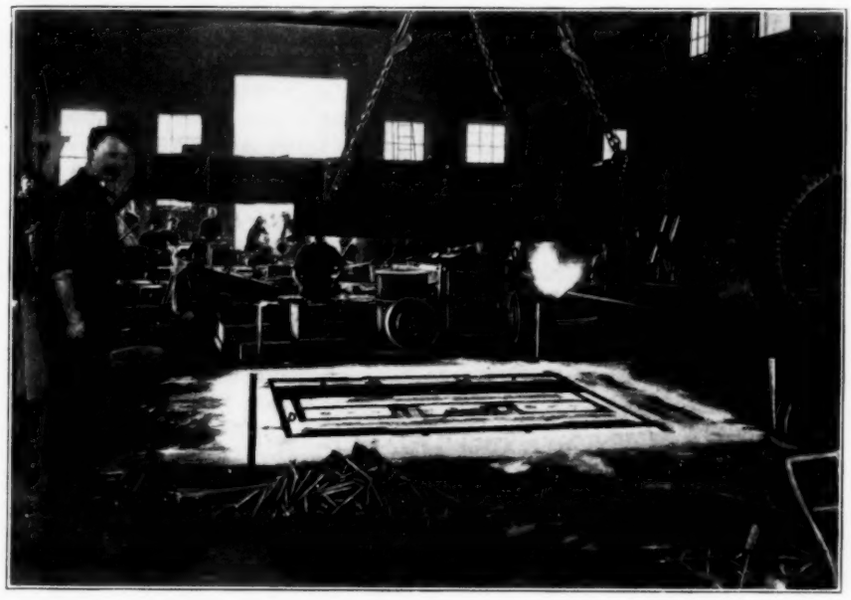


FIG. 5. READY TO CLOSE THE MOLD.

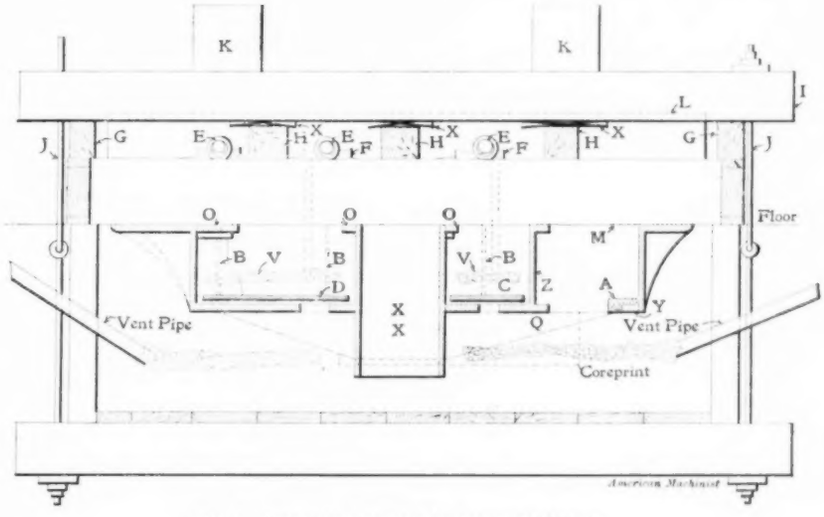


FIG. 4. VERTICAL SECTION OF MOLD COMPLETE.

The buckets of a Pelton water wheel in Nevada, only 18 inches in diameter, have in five years of constant running traveled, it is computed, no less than 2,000,000 miles.

Letters From Practical Men.

The Slow Acceptance of Improvements.

Editor American Machinist:

Although, as I have already assured the readers of the "American Machinist," I am a professional and persistent optimist, it is easy enough for me to find incentives to discouragement if I set out to do so. The winning trick of life is to find encouragement in discouragement. Perhaps one of the most discouraging things in the technical line is the slowness with which certain most evidently desirable reforms and improvements are adopted. We almost all of us individually become assured that there are many better ways of doing many things, and then we can't help but wonder that those better ways are not at once universally adopted. Some are adopted so slowly that we are not really sure that there is any progress at all. We go on in the old ways, without the possible increased efficiencies and with the familiar inconveniencies and making the desired changes increasingly more difficult.

There's the metric system. Those who have thoroughly caught on to it, who realize its great convenience for measuring, and more especially for interchanging, reducing, comparing and computing the measures which now occur so numerously in all technical operations, continually wonder why it is not universally adopted. Well, why wonder at all? All the advantages of the system were certainly as evident a century ago as they are to-day, and the adoption of it would have been much easier then than now, and yet all did not at once jump at it. Fewer inconvenient and costly changes would have entailed at the beginning of the nineteenth century than at the beginning of the twentieth century are required. We have in the meantime made so many things to feet and inches, to pounds and ounces, to gallons and pints; we have so many measures and gages and standards that would have to be

changed that these results of our folly have themselves come to be urged as among the chief reasons against a change.

We are all sufficiently familiar with the absurdities of our wire and sheet metal gages, any one of which begins nowhere, ends nowhere and tells you nothing of actual sizes anywhere between, each gage differing all along the line from each of a dozen others. It would be so easy and simple to give actual measures in fractions of the inch, if not in millimeters, so that we would always know where we were. Who can really say why we don't do it?

There are other things just as bad. The case of the thermometer is decidedly worse. The yard and the meter are after all arbitrary standards not practically referable to or correctable by anything that is certain and unchangeable, while the Centigrade thermometrical scale is fixed by natural phenomena at both ends of it. With melting ice and boiling water we may at any time produce or reproduce it, while the Fahrenheit taxes your memory at both ends and tangles your arithmetic at all points. The Centigrade might replace the Fahrenheit universally and at once without the change of tools and standards involved in the adoption of the meter. It might be changed with practically no expense or inconvenience, and yet, while so much easier, it is, as things look, rather less likely to soon win than the meter.

When we realize these things it really seems as if the mechanics of the land were a lot of simpletons not to see the advantages of the improved facilities offered, or mulish in their obstinacy not to at once and universally adopt them. The fact is that after all the mechanics are no worse than and no different from other people, and we don't have to go far for instances which, while not in the least justifying, do to some extent explain. You walk the streets of New York, the streets where the masses live, and you will see very commonly in front of grocery stores such signs as this: "Three and a half pounds of rice, nineteen cents," "Three and a half pounds of sugar, sixteen cents." (Not sure about the actual market prices.) This three and a half pounds is a common unit of weight among the retail grocers of New York, and that it is so recognized and accepted is evidenced in the fact that I have a tin sugar box, bought in a New York house-furnishing store and made for the city trade, on the front of which is stenciled in white paint "3½ Pounds of Sugar."

To acount for the inconvenient unit of weight we have only to remember that 3½ pounds is an aliquot part, 1-32, of the old gross hundredweight of 112 pounds. To account for the persistency with which the measure is clung to we have to fall back on the inertia of the collective human mind.

This is not the only instance. Not more than a week ago I saw in front of another New York grocery: "24½ pounds of flour, 53 cents." (Am sure of all the figures this time.) If anything, this is rather worse than the sugar and rice business, but the explanation in this case, too, is not hard to find. The 24½ is ⅛ of 196 pounds, the weight of a barrel of flour, and 196 pounds was originally 14 stone, or 14 times 14 pounds. We don't hear of the stone being used as a unit of weight with us any more, but its inconvenience survives in the barrel of flour. What a simple and easy thing it would be to change the weight to 200 pounds, and how easy it would be then to subdivide it into easily computable portions. It is said that this little reform was actually attempted years ago, and that they began to send out from a certain mill barrels of flour of 200 pounds, but the people began at once to argue that on account of the increased quantity the flour must be of an inferior quality, so that reform was knocked in the head very suddenly.

Advocates of the metrical system and other idealists may find encouragement in these things. I hope they do.

TECUMSEH SWIFT.

The Bonus System of Rewarding Labor.

Editor American Machinist:

I read your account of the proceedings of the American Society of Mechanical Engineers, page 1379, with much interest. If the idea of the bonus system has penetrated the cobwebs of my "old fogyism" aright, I want to file my demurrer.

The fact that there has been a 200 to 300 per cent. increase in the output is not convincing proof of the perfection of the system. I have seen a 30-foot boring mill working at a speed and with a cut that most of us would think a disgrace to a 3-foot mill. Here a 500 per cent. increase in output was easily possible without instruction cards, stop watches, etc. I do not infer that tools were ever run in this way at the Bethlehem works. I do know, however, that in many large shops the work done on large work, on heavy tools, is entirely out of proportion to that done in some small shops on small tools. I know a small shop where the common practice on a 36-inch planer is to remove 7 to 8 pounds of cast iron per minute on a finishing cut.

The system may be educational, but I should want to see it from a view point, other than that of the office or engineering department, before being convinced. There seems to be in the large shops a constant decrease in the democratic spirit that seems to me very much to be deplored, as democracy in the shop seems to me essential to the highest efficiency. The growing tendency to ignore the greasy mechanic is progress in the wrong direction. I do not wish to reflect on the engineering department. Co-operation with the brains in the shop can do it no harm.

I think Mr. Taylor is in error in regard to the possibilities of getting good foremen. The system, as I see it, does not require a foreman; a well-designed automaton could be operated with perforated cards to perform most of the functions. There are enough men who are capable, but most men who have sufficient brains and ability to make them desirable foremen steer clear of the large shops. The compensation offered foremen in such shops is not sufficient to induce a man who has the required qualities to bury himself.

The office does not understand the mechanic, and I presume never will. The office thinks it is simply a question of dollars and cents. The mechanic is a peculiar animal in some ways. Sometimes he has hidden away, under his dirty cap and greasy jumper, ideas and ideals of his own. To have a fresh "tech." insist on his doing tapping on a sensitive drill without any arrangement for backing up (actual occurrence in one of the best known shops in America) sort of jars him, don't you know.

With due respect to Messrs. Gantt, Taylor, *et. al.*, I do not think that they know exactly the feeling that exists in their own shop in regard to their system. Recently I have been enabled to get a view of both ends at close range. I have no personal knowledge of the Bethlehem works, but I infer that they have nothing more than men in either office or shop. My observation is that he is indeed a poor man who will not improve the quality and the output if encouraged to do so. This bonus system as outlined seems to me antagonistic to our democracy. Someone will say there are our suggestion boxes. They are a delusion with a big D and a dash. I can, if the fog is not too thick, show you from the "American Machinist" office a shop employing 800 to 900 men that has suggestion blanks and boxes galore. I inquired of one in the engineering department as to the results. He said: "The men think too much of their jobs to monkey with those things. The engineering departments should widen their gage."

In one shop, the other day, the amount and quality of work being turned out on a big radial drill attracted my attention. I spoke to the workman and he showed me his drill; he had ground it to suit the job. I asked him about the drill grinder, and he said that which would look out of place in a moral and respectable paper such as the "American Machinist." Now, suppose this man put in a suggestion as to the grinding of drills, it is useless to speculate as to the result. Has not Prof. Sweet for years been trying to teach us how to grind drills? With instruction cards and a theoretically correct grind on the drill, I think it a safe guess that you would cut the output of this man 20 per cent. Yet we "jolly" ourselves into the belief that we are broad gage and liberal. Not long ago I was watching the operation of a most ingenious machine, designed by one of New York's up-to-date

engineers. The machine has a weakness and the workman had a remedy, but he was afraid to suggest it, for fear he would be sat on without a hearing.

I imagine the elementary rate-fixing department would have to work overtime and have watches to read to the thousandth of a second in some shops. Take a shop building, to order, machines ranging in weight from 10 to 60,000 pounds, and there are plenty such. The estimating done by experienced men in such shops is astonishing. They jump at it in less time than you can get out your slide rule.

In saying that it is illogical to allow the workman to determine how the work is to be done, Mr. Taylor assumes either that the man who makes out the instruction cards knows the individual characteristics of each machine or that their machines are perfect. I am inclined to think that neither of these conditions exists. That machine tools develop an individuality, on thorough acquaintance, is beyond question. Assuming that we have a mechanic of ordinary ability and a reasonable amount of interest in his work, we will get more and better work by allowing him to utilize his machine to the best advantage. Of two lathes, of the same make, size and pattern, and under as near as possible the same conditions, one will do more and better work than the other. A different shape of tool, change of feed, cut and speed may reverse the advantage.

To reach the maximum efficiency of a tool, I do not believe inflexible rules as to speed, feed, cut, etc., will hold. From this point of view the premium plan would seem best calculated to educate the men to obtain the greatest efficiency. Perhaps I am giving the mechanic credit for more than he deserves, but I think not. I cannot believe in obliterating the individuality of the workman; instead, better study and utilize it.

In one shop we had a lathe hand who could make a better taper hole with a boring tool of his own design than anyone else could with a reamer. Now, give this man instruction cards, reamers, etc., and you would not get as many holes or as good ones. Every good mechanic has something in him that a good foreman can direct and utilize to advantage. To treat a man as a machine is, to my mind, unfair and unprofitable. I believe in a reasonable amount of instructions, but it sometimes happens to us finite mortals, that we feel away down in our hearts that the man to whom we are giving the job knows better how to make time on it than we do.

I understand that under the bonus plan there is no incentive for the workman to get below the minimum time, which takes away the inspiration to devise means to cut the time, and it has happened that a workman has thought of a way to cut the time a considerable amount on well-planned jobs. W. A. WARMAN.

On the Management of Foremen.

Editor American Machinist:

A paragraph taken from "The Roller Mill" on page 1403 of the "American Machinist" has started my thoughts out over a neglected field of methods for controlling and influencing those who have authority over us in our daily work. With all the articles and speeches on the management of workingmen, it is passing strange that no one has thought of the possibilities of the other side. I will give a little of my limited experience with the hope that others may add still more to our available data along this line.

One of the first things I learned as an apprentice was to overcome my fear of the boss. It is a great pleasure to a certain type of foreman to have his workmen strung up to such a pitch of nervous terror that he will give a two-foot jump every time their eyes chance to meet. The excited haste that one of these poor unfortunates is driven to by the mere appearance of the dreaded monster at the far end of the shop is pitiable. I have heard it said of the employees of a certain shop where this state of affairs largely exists that they may be easily distinguished on the street, even when going to church of a Sunday morning by their habit of giving every few moments a startled jump and a furtive glance over the shoulder. All this may tickle the vanity of the *charge d'affaires*, but in his inmost soul he prefers the man who, while giving him the respect due his position and attainments, can yet stand firmly on his feet and bear without quailing the withering glance of his eagle eye. An unfortunate of the type here suggested can never hope to make the slightest headway against his haughty adversary. After long experiment with bosses of various weights and complexions, the best attitude has proven to be the happy mean which lies between nervous and abject terror on the one hand and "sass" and bumptiousness on the other.

Still it is needful to avoid undue familiarity. This is bad for both sides. The effect on shop discipline is of course self-evident; but on the workman's side also there are very good reasons for holding our superiors off at arms length. It is very difficult, for instance, for a loquacious, easy sort of a man, who swaps stories with the boss while a long cut is running in the lathe, and thumps him roundly on the back every time they meet in the street, to convince him that he hasn't told all he knows, and some things he doesn't, a dozen times over. If, however, a man goes about his work in a steady, confident sort of a manner, with his mouth shut when there is no urgent need for opening it, he will gain such a reputation for ability that living up to it may take all his assurance and ingenuity.

An unfailing source of interest and instruction will be found also in the study of the characteristics and idiosyncracies of individuals of the class under discussion. It will be found that ofttimes deference may be paid to peculiar traits of character in the boss without in anyway sacrificing one's self-respect. Different men demand different treatment. There are, for instance, the dyspeptic, sharp-tempered variety, the jovial and familiar one, the sneaking and suspicious, the fussy and worried, the lazy and careless, etc., and occasionally a specimen of that rarest of rare birds, the dignified and intelligent man. The mere mention of a few of the endless varieties shows the magnitude of the field awaiting the investigator.

In all seriousness, it is a legitimate and profitable undertaking to study unobtrusively but carefully by observation and experiment the failings and virtues of the men we work for. They may never realize it, but often a little skillful maneuvering with likings and prejudices will gain long-desired favors and put new life and interest into the daily task. EBEN BONES.

Press for Making Hydraulic Leathers.

Editor American Machinist:

Can any of the readers of the "American Machinist" give me information on a press for pressing leather in molds to form cup leathers for use on pumps?

We are using a screw press. The screw is ½-inch pitch, but it is too slow and does not give sufficient pressure. We think a 20-ton hydraulic press would be about right. How large an accumulator and pump would we need for such a press, the press to make two 4-inch strokes per minute? A. D. GAGE.

Finding Centrifugal Force by the Slide Rule.

Editor American Machinst:

The following method of finding the value of centrifugal force by the slide rule will be of use to those who have many such calculations to make:

For this problem a convenient starting point is the radius at which the centrifugal force is equal to the weight of the revolving mass at, say, 100 revolutions per minute, which radius is equal to 3.52 inches very nearly. At 352 on the right-hand half of the upper or *A* scale of the slide rule place a mark—that being easier than remembering the number. Reverse the slide and bring 1 of the *C* scale opposite the mark. The numbers on the *C* scale, which is now the upper scale of the slide, represent revolutions per minute and they stand opposite the radii at which, for those speeds, the centrifugal force is equal to the weight of the revolving mass. For instance, opposite 200 revolutions per minute, read .88 inch, and opposite 300 revolutions per minute read 0.392 inch. The ratio between this radius and any other radius, multiplied by the weight of the mass, gives the centrifuged force at that radius. The radius determined may be located by the runner when, by replacing the slide in its normal position, the final answer may be quickly found. E. J. ARMSTRONG.

AMERICAN MACHINIST

Published at 218 William St., New York, every Thursday by the

American Machinist Press.

[INCORPORATED.]

Also published at 34 Norfolk St., Strand, London, W. C.

Correspondence on mechanical subjects solicited. Name and address must always be given—not necessarily for publication.

Address all business communications to the American Machinist Press. Matter for reading columns may be addressed to the Editor.

Subscribers can have address changed at will. Give old and new addresses. Date on wrapper denotes end of month in which subscription expires.

Subscription Price:

$4 per year, postage prepaid, to any post office in North America, $5 in all foreign countries except Europe; Twenty-five Shillings there. No back numbers beyond current year. For sale by newsdealers generally.

European subscriptions served by the AMERICAN MACHINIST CO., LTD., 34 Norfolk St., Strand, London, W. C.

Entered at New York P. O. as mail matter of the second class.

Cable address, "MACHINIST," N. Y. Lieber's and A B C Codes.

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Trade Secrets and Confidential Relations.

Referring to the former editorial under this caption, a reader sends in the following query:

"I read with interest your article, page 1390 (1901), 'Trade Secrets and Confidential Relations.' In Judge Ingraham's summary he says: 'When such an employee *left* the plaintiff's employ he should not accept a position,' etc. The question arises in my mind, Would the argument apply had the man been *discharged?* Can you enlighten me?"

Every case at law suggests an indefinite number of queries as to what would happen under this or that variation of the conditions. Often these questions are unanswerable without an action at law directly upon the issue. The present hypothetical case, however, may be decided off-hand with a fair degree of confidence.

A contract of the sort referred to naturally provides that the employment is to last for a definite length of time. If the employee is discharged before the expiration of that period, without sufficient cause, it constitutes a breach of the contract on the part of the employer, and the employee is no longer bound by any of its provisions. It is barely possible that if he had been initiated into important trade secrets he might still be restrained by a court from using them against the company, but we think that this would be unusual and that it would have to be based on something besides the mere terms of the contract.

If the employee were discharged for a legally sufficient cause—as, for instance, where he had been acting in a manner subversive of the business of the company, so as to render the continuation of his employment intolerable to them—the responsibility for the breach would rest with him, not with his employers. The conditions would then be substantially similar to those of the Magnolia Metal case, and if the principle there laid down were followed, the ex-employee would not be allowed a free hand to turn the information he had gained against his former employers.

If after the time of employment stated in the contract had expired the services of the employee had been retained under an informal arrangement, and he had then been discharged without cause, it would not be a breach of the original contract, and any restraints upon his subsequent conduct that might remain under the terms of the original contract, which had been carried out on the side of the company, could be enforced against him.

"But," our correspondent may further ask, "suppose no time of employment had been provided for by the contract." In that case it is questionable whether the contract would be a valid one, since there would be no obligation on the part of the company as a consideration for its fulfillment by the employee. The court might hold, however, that the "trust and confidence" shown by the company in revealing their secrets were sufficient consideration to sustain the agreement. If so, it is difficult to see how discharge of the employee at any time would be a breach by the company, and why he should not still be bound by its terms.

Some Cases of Arbitration.

An unusual case of arbitration of a labor difficulty occurred in Brooklyn recently, wherein the employees of a shoe-manufacturing firm, Wichert & Gordon, demanded that the rate for making certain styles of shoes be increased. The men also objected to certain requirements made of them in departments wherein day's work is demanded of them at times. In this case, as a result of former troubles, the employers and the men had agreed to and had each put up $10,000, which was to be forfeited by the side to any dispute which refused to accept the results of any arbitration which might be agreed upon. The employees accumulated their fund by small deductions from their pay extending over a considerable period and at the time of the difficulty the fund of $10,000 had been fully accumulated. In this case State Mediator Bernard Stark was called in as arbitrator and his decision was entirely in favor of the employers, and the men of course accepted the decision. It is to be noted that in this case the verdict was not of the usual compromise character, but was entirely upon the side which it is believed the arbitrator thought was the just side, and the question arises in this connection whether the decision was not so rendered because the arbitrator knew that his decision would have to be observed and he was not therefore compelled to render a compromise verdict in order to have it accepted or be of any use.

The Arbitration Committee of the National Civic Federation has also accomplished good work in settling a difficulty between garment workers and their employers. Some of these had asked for a reduction of the day's hours from 9 to 8. A disastrous strike was threatened on account of disagreement on this point, the manufacturers declaring that they never would accede to the demand and the men insisting that they would quit work and never return until the demands were granted. At this juncture the Arbitration Committee stepped in, and by bringing the parties together brought them into a frame of mind which has led to the doing away of all likelihood of a strike, and it is more than probable that serious difficulty will be entirely avoided.

In these two cases very great loss both to employers and employees has been avoided by means of arbitration and it seems to be becoming constantly more clear that there are other and better ways of settling labor difficulties than by striking, although it is probable that under present conditions the possibility of a strike will always loom up in the background of differences that may arise.

The American School of Correspondence.

We have been favored with a copy of the "Handbook of the American School of Correspondence," located at Boston, Mass., with which has also been sent a copy of the instruction paper on "Boiler Accessories," which forms a part of the course in Mechanical Engineering.

The location of this school in New England has naturally caused it to include in its work courses of instruction in the textile industries. It has one full course in Textile Engineering and shorter special courses in Warp Preparation and Weaving, Textile Design and Fabric Structure, Cotton Spinning, Woolen and Worsted Spinning and Textile Chemistry and Dyeing. The fact that we have so few schools related to the textile industries (we know of but two in the entire country), while these industries are of enormous proportions and importance, opens a large field of usefulness for correspondence instruction and one which seriously needs attention.

The paper on "Boiler Accessories" enforces to us the nature of the service which these schools, and for that matter all schools, render to their pupils. Examination of this pamphlet will disclose nothing that is new, and the doubter says: "All this matter can be found in books and technical papers; why should the student not buy such books and papers, and so save the expense of the instructors' and examiners' work?" The same objection can be raised regarding university instruction and text books, and it would be just as legitimate to ask why a prospective university student should not buy those books and so save the expense of attendance at the university. The chief work of any school—correspondence or other—is in arranging a progressive graded course of work which can be followed systematically, with the teacher's aid at command to give help when needed. Only those who are already familiar with the ground covered can select a series of books or lay out a course of study in any subject. For the beginner to attempt to do this for himself, involves an enormous waste of time and effort, with the final result that the work done has many gaps and is correspondingly unsatisfactory. Whether he knows it or not, it is this difficulty which is the great obstacle to anyone attempting unaided to educate himself. The knowledge that his work is being guided and directed by those who are capable of doing it, gives the student—unconsciously perhaps, but still really—just that spirit which leads him to undertake and persevere in the work. This paper on "Boiler Accessories" is a compend of information. To find the sources from which it came, even with the pamphlet before one, would be difficult, and without it almost impossible, while, if found, it would be encumbered with a mass of other matter, much of which would be irrelevant. It is safe to say that the student could hardly find it at all. Even the argument of expense falls to the ground in the face of the cost of getting these sources of information together. More than this the student finds here a ground work of principles which gives him an intelligent grasp of the general subject, and which detached sources of information would not supply. We are convinced that the corespondence system of instruction is essentially sound, that it meets the needs of many, and that it meets them well. We know from observation and unimpeachable evidence that, while the work has its limitations, it is thorough and even exacting. Like others, these schools cannot make bricks without straw, and a greater degree of determination is no doubt necessary on the part of their students than others, but this is saying nothing against them or against the great good that they are undoubtedly accomplishing.

Case Hardened Screws Wanted.

A responsible machinery manufacturing concern write us that they want to obtain case-hardened screws in lots of 10, 20 or 30 at a time of the following dimensions: "Screws 3 inches diameter, square thread, 1¼ inches pitch, ¾ inch deep, ⅝ inch wide, 6 feet 10 inches long; screws 3 inches diameter, square thread, 2¾ inches pitch, ¾ inch deep, ⅝ inch wide, 6 feet 10 inches long. Length over all with bearings, 8 feet 11¼ inches. Half of these screws are to be right and half left hand."

The manufacture of these screws, up to the point of case hardening, will be recognized as a comparatively simple matter, but to case harden such screws and have them retain any degree of accuracy will be recognized as a pretty difficult job. We are not informed as to the limit of error that will be allowable, but anyone who would like to undertake the work will be put in the way of obtaining full information about it by communicating with the editor.

A Telephone Decision Case.

A case has been decided in the courts at Chicago recently which is of interest to manufacturers and other large users of telephones. It seems that the Chicago Telephone Company in securing a franchise made a contract with the city which specified the maximum rates to be charged subscribers. A subscriber finding it impossible to get satisfactory service at the rate fixed by the franchise contract agreed to pay a higher rate for a better service, which was given in consideration of the extra payment. The subscriber then refused to pay the extra charge on the ground that the franchise price contemplated a satisfactory telephone service and that it should have been given for the amount fixed by the contract. The court decided that the subscriber's view of the case was correct, and quoting the language of the Supreme Court says: "Where a public service corporation exacts greater charges than are authorized by law, the payment of such charges is not regarded as voluntary, nor is the making of any protest or objection necessary in order to recover back the excessive charges."

This decision seems to be directly contrary to the decision of the courts in New Jersey, where it has been decided that a municipality cannot contract with a company installing a water works so as to restrict the amount that the company can charge to private consumers of water; the position taken by the court being that a municipality has authority to contract only for its own supply of water and that it has no right to specify rates at which the water company shall supply water to private individuals or consumers. If the municipality has no right to make such restrictions as regards water supply, then of course it has no right to do so with regard to electric lights or telephones.

Technical Publications.

"Metallurgy of Cast Iron." By Thomas D. West. Third edition. 627 5x7½-inch pages, with 153 illustrations. The Cleveland Printing & Publishing Company, Cleveland, Ohio. Price, $3.

The third edition of this book contains a large amount of new matter, some twenty additional chapters having been written for it. To make room for this matter several chapters on Cupolas, which related to foundry practice rather than to the subject proper of the book, have been transferred to Mr. West's "Molders' Text Book." Of the new matter the most notable, perhaps, is that contained in Chapter 70, which relates to the methods of casting test bars for the American Foundrymen's Association and to the tests thereon, in which, as carried out by the author, all test bars of differing size and form but of the same metal were cast from the same ladle, and so quickly that the pouring temperature was substantially the same for all the bars. The first set of bars numbered 192, and these were all cast within twenty seconds—a circumstance which eliminates the question of the pouring temperature and makes the tests that much more consistent and comparable. In this series 1,600 tests were made on bars aggregating about 15 tons in weight, and tables of the results of the more important tests are given.

"The Engineering Index." Vol. III, 1896-1900 inclusive. Edited by H. H. Suplee, assisted by J. H. Cuntz. 1030 6½x9-inch pages. The Engineering Magazine, New York and London. Price, $7.50.

This index is primarily a republication of the monthly index which appears in the "Engineering Magazine," which in turn is a continuation of that formerly published in the "Journal of the Association of Engineering Societies." It is, however, much more than an assembled reproduction of the monthly index, the matter having been re-edited and a system of cross indexing,

which could not be included in a monthly index, has been added. The monthly index may be called a current table of contents of engineering periodicals, while this volume is a true index. As stated in the introduction, such an index is consulted by two classes of readers—those in search of a certain specific article and those in search of information on some general subject, and the only real test of such an index, as of an engineer's pocket book, is actual use. We have endeavored to give this index such a test from the standpoint of the first class of users, and the result is eminently satisfactory. Taking our back numbers and selecting a large number of articles such as might be expected to be indexed, we have looked them up. In but two instances, when indexed at all, have we failed to find them without difficulty, and in most cases the first reference either found the article or a cross entry leading directly to it. Indexing is a difficult art—no one knows how difficult until he has had some experience with its practice—and we take our test of the book to be a good indication of the manner in which the work has been done. The work involved is of almost monumental proportions. The book contains nearly 40,000 entries taken from nearly 200 sources—American, English, French, German, Italian and Spanish. There can be no question as to its great importance and value, and we hope our contemporary may receive the substantial reward which its enterprise merits. We note one curious omission. We believe that our articles on the exhibits at the Paris Exposition were the most extended and comprehensive of any series on that Exposition published by any journal. Although a large number of entries refer to articles on the Exposition, we are unable to find any references to our own. This is not written in a complaining spirit. Ours is, in fact, about the last publication which has any right to complain of the manner in which its work has been recognized, as we doubt if any other paper has been given so many entries as our own, but the omission strikes us as a curious one; the more so as the series referred to includes illustrated descriptions of many interesting machine tools not elsewhere described by any American publication. The index will hereafter be published annually.

We have received the program of a concert and dance given under the auspices of the Mechanics' Mutual Relief Association of the Morse Twist Drill & Machine Company, which we judge must have been a very enjoyable affair. With this program we have some historical facts connected with the association by which we learn that it is now about twenty years old; that its object is to render aid or relief in time of sickness; that during its existence 190 members have received benefits, the total amount paid out in this way having been about $3,000; the annual cost to a member since its organization has been $2.69 and for the past four years $1.63. It is stated that the funds of the association are in good condition and that its membership has been largely increased during the past year.

It is reported that a master blacksmith of Homberg, Germany, named Knigge, has discovered a process of hardening iron; that he has hardened a large number of pieces for prominent German manufacturers in such a manner as to convince them of the great value of the process; that Herr Krupp is much interested in (or exercised by) it, and that an English company has offered Knigge 300,000 marks (about $75,000) for it.

We have received a pamphlet containing an article on the explosive "Maximite," by Hudson Maxim, inventor, from the "Journal of the Military Service Institution" as reprinted in the "Anglo-American Magazine." The things that can be done to this stuff without its going off are set forth in the pamphlet very graphically. You can shoot it through a piece of armor plate, pour melted iron over it or use it for a cigar lighter and it behaves about as lively as a piece of brick. The question naturally arises how they ever manage to explode it when they want to—but the results show that they do it all right.

A pamphlet on "Commercial Reciprocity" considered as both a historic and live question has been compiled by the Committee on National Legislation of the National Association of Agricultural Implement and Vehicle Manufacturers. Copies will be mailed on application to the secretary, Frank E. Lukens, 1433 Monadnock Building, Chicago.

"The Chronicle," a weekly insurance journal at 97 Cedar street, New York, published for the 19th ultimo, a fire suppression number which contains matter that might be of interest to such as are grappling with this problem. One of the articles is by Frank H. Quimby, architect, on the Fireproof Factory Building.

Personal.

F. Wesley Parker, formerly with the Morse Twist Drill & Machine Company, is now with Manning, Maxwell & Moore in New York.

Wm. C. Briggs, who for ten years was with the Gas Engine & Power Company, is now in charge of the machine shop of the Samuel Moore & Sons Company at Elizabethport, N. J.

Wm. B. Murdock, who for some years past has represented the Pratt & Whitney Company and more latterly the Jones & Lamson Machine Company in England, is now with Manning, Maxwell & Moore in New York.

W. H. Tew, formerly connected with the American Locomotive Company, Brooks Works, Dunkirk, N. Y., and later with the mechanical engineering department of the Chicago & Northwestern Railroad, has been appointed managing director of the newly organized German branch of the Standard Pneumatic Tool Company, with headquarters at Klosterstr. 13-15a, Berlin, Germany.

The Chicago Pneumatic Tool Company's executive board have just announced the following appointments: W. O. Duntley, vice-president and general manager; C. F. Walker, assistant general manager; Thomas Aldcorn, general sales agent; W. P. Pressinger, general manager air compressor department; Charles Booth, manager Chicago office; S. G. Allen, manager New York office.

P. H. Patriarche, formerly with Crescent Steel Company, and Park E. Bell, with Park Steel Company, both of whom are very well known in the steel trade, have formed a partnership for continuing in the steel business on their own account under the firm name of Patriarche & Bell. They have secured a warehouse at 215 Pearl street, New York. An intimate personal acquaintance with Mr. Patriarche and his methods enables us to feel very sure that the new firm will be a very creditable addition to the steel trade.

Obituary.

Edward R. Jones died in this city, January 8, seventy-two years old. Mr. Jones was born in Hartford, Conn., and as a boy he began working in the foundry of his father's firm, Jones, Fowler, Beebe & Co., which was moved to this city in 1840. The business still exists under the name of Jones & Kirtland, although Mr. Jones had retired.

Edward S. Hutchins, chief draftsman of the Bath (Me.) Iron Works, died December 28, thirty-seven years old. Mr. Hutchins was born in Providence, R. I., graduated from the Massachusetts Institute of Technology, where he remained some time as an instructor, and in 1890 entered the drafting room of the Bath Iron Works as an assistant draftsman. He became chief draftsman in 1894.

Marcellus Hartley, senior partner of the well-known firm of Hartley & Graham, now M. Hartley & Co., died suddenly January 8, seventy-three years old. Mr. Hartley was a native of this city and his first business experience brought him into contact with guns in the importing house of Francis Tornes & Sons. In 1854 the firm of Schuyler, Hartley & Graham was formed, from which the present business has grown. In the early days of the Civil War Mr. Hartley was sent to Europe by Secretary Stanton to purchase arms for the Union Army, in which business he rendered most valuable and efficient service to the nation. He not only secured the arms required but largely blocked the plans of

the Confederate emissaries in the same line. Mr. Hartley acquired not only fame but wealth, and at the time of his death was president, director or trustee of fifteen large corporations.

John G. Sadlier, vice-president and general manager of the Springfield Foundry Company, Springfield, Ohio, also of the Fairbanks Machine Tool Company and of the Indianapolis Switch & Frog Company, of Springfield, was shot and instantly killed by a discharged employee on January 6. Mr. Sadlier was forty-five years old. He was born in Johnstown, Pa., and when twelve years old began an apprenticeship in the foundry of the Cambria Iron Company. After serving his time he went with the Morgan Engineering Company at Alliance, Ohio, and soon became their foreman. He was after that foreman of several of the largest foundries in Ohio, and later became a member of the Springfield Foundry Company, assuming entire charge of the plant. Mr. Sadlier was a member of the American Foundrymen's Association from the beginning and was elected president of that body at its last meeting, held at Buffalo. At that meeting he read a paper on "The Problem of the Molder."

Some New Things.

COIL THREADING MACHINE.

The Reliance Machine & Tool Company, of Cleveland, O., have brought out a new form of threading machine which is designed especially for threading the ends of pipe coils. The machine is essentially the same as those previously built by the same company, except that the carriage has its

AN ALL-STEEL PULLEY.

slides in advance of the work-holding jaws. That is to say, the slides are entirely under the die head. Thus the jaws are brought at the extreme end of the machine, and the flat coil of pipe can be of any diameter without interfering with the operation of the machine. It may in fact extend to the base of the machine if desired.

NEW STEEL PULLEYS.

The half-tones show two pulleys of different styles made by the Oneida Steel Pulley Company, Oneida, N. Y., one of these being made entirely of sheet steel, while the other has a wooden rim. The construction of the pulleys is quite clearly shown. The arms, it will be seen, are stamped up separately, giving the most advantageous shape for combined stiffness and lightness, and are riveted to the hub and to the steel rim, or to the webs which secure the wooden rim. Iron bushings are used in the hub to fit the various sizes of

STEEL PULLEY WITH WOOD RIM.

shafts. The pulleys, as will be seen, are very neat in appearance and either style weighs about the same as a wooden pulley of the same dimensions. A full line of sizes will be manufactured.

A PROCESS OF HARDENING AND TEMPERING STEEL.

The cuts show the apparatus employed in hardening and tempering steel by a process recently patented by William R. Bennett, of New Britain, Conn.

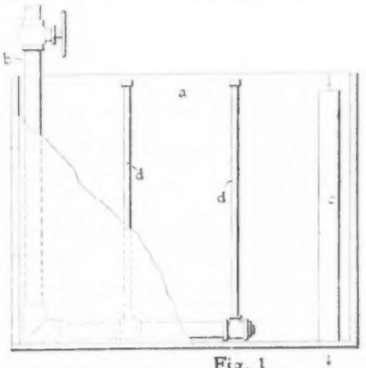

Fig. 1

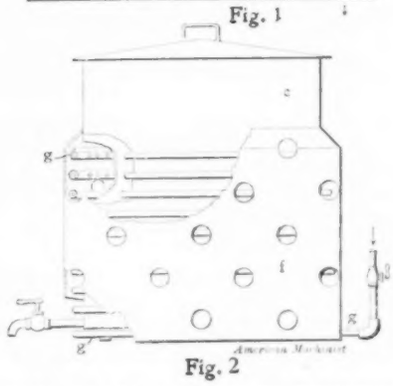

Fig. 2

TANKS FOR HARDENING AND TEMPERING STEEL.

Fig. 1 is the hardening tank. This is to contain water or other preferred cooling liquid. The tank is kept full to the top of pipe *c* where it overflows, a constant circulation being maintained during the hardening. The water flows down through pipe b and rises in pipes *d*, of which there may be more than here indicated. These pipes have vertical slits in the sides facing each other, from which the water is discharged. The piece to be hardened is held between these pipes, and the circulation of the water causes it to be cooled more rapidly than if the water was quiescent. The stock is left in the water until the vibration incident to the cooling is felt to be nearly stopping, when it is suddenly lifted from the hardening tank and immediately immersed in the oil tank, Fig. 2. The vessel *e* containing the oil, preferably animal oil, is surrounded by the jacket *f*, perforated for the inflow of air. *g* is a gas pipe with numerous apertures so located and directed that their flames when ignited will play upon the vessel *e*. This pipe should have jets below the oil vessel *e* as well as around it. The cock at the left is for drawing off the oil.

The oil in the tank would normally be at about the temperature of the room, or, say, 80 degrees. The stock taken from the hardening tank and immersed in the oil is kept there until it has heated the oil to the same temperature as itself. There is a thermometer in the tank for indicating the temperature. After the oil has thus been heated by the stock the gas flames are lighted and the oil and stock are heated together to the temperature required, say 380 to 400 degrees. The oil when inclosed will not ignite below 550 to 565 degrees. After the stock has been thus heated to a desired temperature the gas is shut off, and it is lifted out and buried in sawdust or other proper material and allowed to cool slowly.

Don'ts for Steelworkers.

BY HORACE ALLEN.

In most engineering shops the only classes of steel that can be readily commanded without the necessity of chemical analysis and testing are:

1. Soft steel.
2. Medium steel.
3. Hard or tool steel.

Soft Steel.—Though this steel cannot be hardened, its quality can be greatly deteriorated by improper heat treatment, as well as by having work put on it at unsuitable temperature. The best soft steel can be rendered more inferior in quality than common iron by failure in observing the following don'ts."

Medium Steel.—The remarks referring to soft steel generally apply to this class of steel, but it has the property of being somewhat hardened when chilled. The

effect of working at a black heat and chilling from that heat is very injurious.

A forging that is heated locally and has work put on it must at some parts be at a *black heat*, and if cooled without annealing the strains set up in the *black hot* portion will remain and render the finished forging unreliable.

Engineers and foremen are advised to cut out the following don'ts and place them in a conspicuous place in the shop:

Don't expect steel to stand the same heat treatment as iron.

Don't attempt to put any work on steel when it is only black hot.

Don't heat steel unless you know the required temperature to which it is to be raised, and the way in which it is to be worked and cooled.

Don't make steel forgings unless you can anneal them.

Don't try to anneal steel unless you are fully aware of the necessary conditions.

Don't when annealing steel keep it long at the highest temperature or it will crystallize.

Don't heat steel above the melting point of copper unless for welding purposes.

Don't heat steel slowly when annealing, but as quickly as its form and size will allow, but cool slowly.

Don't let a steel forging that has been worked at different times and heats leave the shop without annealing.

Don't leave any sharp corners about steel that has been forged or turned.

Don't work steel when lead will not melt upon it, as you will then make it "rotten."

Don't punch or stamp steel without removing the strains set up, by either annealing or reaming out the hardened portion.

Don't chill steel from black or blue heats.

Don't, when cooling steel after annealing or heating, allow thin or light portions to be chilled from a black heat by coming in contact with anything cold.—"Mechanical World."

Commercial Review.

NEW YORK, Monday, January 13.

MACHINERY TRADE AND INDUSTRIAL NEWS.

The trend of trade in machine tool and other lines may be briefly summarized by stating that business is moving with alacrity, the period of hesitation which generally marks the beginning of the year being conspicuous by its absence. A sign of conditions in the machine-tool line is a difficulty which some manufacturers are experiencing in getting castings. Of similar import is a shortage of cars to move freight, one large conveying and power-transmitting machinery company in the West stating itself to be much embarrassed from that cause. It is to the famine in cars which was especially marked around Pittsburgh that the somewhat disappointing report of the United States Steel Corporation for the December quarter may in part be attributed. The quarter's earnings proved to be a trifle short of $30,000,000, whereas the expectations of sanguine individuals had run them up as much as 20 per cent. higher. The quotations in the stock of the company have in consequence sagged off a little. It is a patent fact that competition with the steel trust is springing up at a prodigious rate. The big company is no doubt beginning to experience the results of this competition more perceptibly than during the few months of its life, and unquestionably when general business becomes a little slower there will be a sharp conflict in the market. The report of the United States Steel Corporation does not justify a belief that a subsidence has yet begun or is imminent. Not only is the volume of trade without visible diminution, but the tendency of prices is upward. Wire nails, for instance, have been advanced 10 cents a keg.

One instance of the competition that is springing up against the United States Steel Corporation is the formation of a new concern, the National Bridge Company, which is in charge of men who have been connected with the American Bridge Company. The company has established headquarters in the Fitzsimmons Building on Fourth avenue, Pittsburgh, and has optioned 47 acres at Monaca, on which it is proposed to erect buildings to cover 14 acres. Meanwhile the United States Steel Company is broadening out its own operations—for instance, the doubling of the Homestead armor plate plant, the building contract for which is expected to be let this month, and which will be completed by the first of next year; also an addition to the wire works at Worcester, which will be used for bale tie purposes.

The most interesting piece of machinery news of the past week in the East is the report that the International Steam Pump Company has purchased a 400x1800-foot tract of land on the Delaware, Lackawanna & Western Railroad in Harrison, a suburb of Newark, N. J., and will build there a large plant. It is expected that seven 140x700-foot buildings will be erected there and that employment will be given to 2,500 men.

The Baush Machine Tool Company, Springfield, Mass., is reported to be in receipt of some large orders for drills from steel companies. The Pennsylvania Steel Company, Steelton, Pa., has placed an order for thirty-six radial drills with 9-foot swing, and the McClintic Marshall Construction Company, of Pittsburgh, has ordered twenty-eight drills. The company's business has grown greatly in the past year and the few years preceding. It is quite probable that in a short time the capital stock will be doubled.

Some power-plant work in the street-railway line that is unusual for a city of any but the largest class is to be done in Baltimore, Md. The United Railways and Electric Company is to equip a new power station in which it is planned to install four alternating current generators of about 2,000 kilowatts each and direct-connected compound engines of about 3,000 horse-power each. The boiler house is nearly completed and the Babcock & Wilcox Company has already sold the company at least 5,000 horse-power of boilers. It is understood that the engines will be of McIntosh, Seymour & Co. build.

When the new Chicago Pneumatic Tool Company was in process of organization it was proposed to include a number of other companies in the business, but there was a disagreement between the promoters and the scheme was not carried out on the extensive scale they had in view. Subsequently, it has been reported that another trust, "The Standard Pneumatic Tool Company," is to be formed and to include the present Standard and other prominent

MACHINERY, MACHINES, AND PARTS OF—	NOVEMBER— 1900 Number.	NOVEMBER— 1900 Dollars.	NOVEMBER— 1901 Number.	NOVEMBER— 1901 Dollars.	ELEVEN MONTHS ENDING NOVEMBER— 1899 Number.	1899 Dollars.	1900 Number	1900 Dollars.	1901 Number.	1901 Dollars.
Cash Registers	1,173	91,068	750	66,242	.....	.....	.....	752,959	10,197	863,892
Electrical	.....	402,293	.....	347,506	.....	2,757,986	.....	4,957,308	.....	5,264,102
Laundry Machinery	.....	30,547	.....	47,947	.....	147,899	.....	442,399	.....	476,748
Metal-working	.....	308,571	.....	304,770	.....	6,082,270	.....	5,855,178	.....	2,678,510
Printing Presses, and parts of	.....	70,057	.....	68,252	.....	922,620	.....	1,137,279	.....	681,460
Pumps and Pumping Machinery	.....	201,627	.....	168,927	.....	2,712,109	.....	2,572,579	.....	1,837,388
Sewing Machines, and parts of	.....	314,130	.....	274,629	.....	3,688,547	.....	4,173,955	.....	3,472,676
Shoe Machinery	.....	63,409	.....	54,333	.....	876,403	.....	952,045	.....	961,292
Steam Engines, and parts of—										
Fire	2	547	.....	.....	4	21,848	13	24,625	8	17,635
Locomotive	19	140,785	41	408,573	462	4,544,350	393	4,059,012	419	3,862,018
Stationary	73	82,984	91	60,439	866	456,027	1,196	761,909	1,152	769,683
Boilers and parts of Engines	.....	131,443	.....	90,092	.....	1,304,565	.....	1,751,391	.....	1,341,189
Typewriting Machines, and parts of	.....	242,160	.....	251,984	.....	2,533,118	.....	2,504,388	.....	2,651,297
All other Machinery, and parts of	.....	1,883,243	.....	1,692,208	.....	17,772,158	.....	21,884,195	.....	17,059,489

UNITED STATES EXPORTS OF MACHINERY OF DOMESTIC MANUFACTURE, INCLUDING THE FIRST ELEVEN MONTHS OF 1901.

companies. We have investigated this report, and what we have learned tends to show that it is worthy of no credence, or at least is very premature.

The Standard Pneumatic Tool Company is about to erect works in Germany for the manufacture of "Little Giant" Pneumatic tools and appliances to supply the trade in Continental Europe. They are now purchasing machinery for the plant mentioned, which they expect to have completed before long. This move has been necessitated by the unprecedented demand for the company's pneumatic tools in Europe, particularly France, Germany and Holland, which they are unable to meet, although they recently greatly enlarged their plant at Aurora, Ill. The export business of the Standard Pneumatic Tool Company during the month of December, 1901, was 100 per cent. greater than the corresponding month of 1900, and they find that there is every indication for a proportionate increase during the present year.

There is excellent reason to believe that a locomotive plant will be established in Canada by the American Locomotive Company. President S. R. Callaway of the company has been in Montreal within the past week in conference with Canadian railroad magnates, and while there was quoted as saying: "We should like to and probably will establish locomotive works here, but nothing has been decided yet."

During the six months ended December 31, 1901, there were built in the United States and officially numbered by the Bureau of Navigation 717 rigged vessels of 154,073 gross tons, compared with 568 rigged vessels of 179,229 gross tons for the corresponding six months of 1900. Canal boats and unrigged barges are not included. The principal decline, 19,762 tons, is on the Atlantic seaboard and is attributable to work on several large ocean steamers, which will be completed during the coming six months.

The Fitchburg (Mass.) Steam Engine Company has on hand a good deal of work booked through the New York office, among which is the following: Three 300 horse-power compound engines for the Greensboro (N. C.) Electric Company, the first of which has been shipped; two 315 and one 125 horse-power compounds for an electric plant on a Porto Rico plantation; a 250 horse-power engine for an electric-light station in Bath, Steuben Co., N. Y.; one 100 and one 300 horse-power for electric lighting at Southampton, N. Y.; a 300 horse-power simple engine for an electric-light station at Coxsackie, N. Y.

An example of a tendency precisely the opposite of trust formation is illustrated by an announcement of Goodell & Waters, of Philadelphia—one of the constituent firms in the American Woodworking Machine Company—that they have purchased the control of their business from the American Woodworking Machine Company, and are no longer a part or a branch of that concern. They further state that they have sold their business to the Cresswell & Waters Company, where the wood-working machinery department will be as heretofore under the direct personal supervision of Mr. Daniel A. Waters, the vice-president and general manager of the Cresswell & Waters Company. The new company will control all patents and patterns of all the machines built by Power & Tainter & Co., E. C. Tainter & Co. and Goodell & Waters. We have already mentioned the reorganization of the American Woodworking Machine Company. The following statement of their changes and plans for the future is contained in a letter by Hiram Duryea, chairman of the bondholders' committee to the "New York Journal of Commerce" intended to counteract the impression that the consolidation is generally disintegrating: "The American Woodworking Machine Company was not a trust. All of the properties operated by the company were owned by it in fee. The company was organized in 1897, at a time of great depression in business, and several of the plants which were acquired were unfavorably located and unprofitable. The company defaulted in the interest on its bonds, and the bondholders appointed a committee to foreclose the mortgage and to take such further steps as the committee might deem necessary in conserving the interest of the bondholders. The mortgage was foreclosed. In October last all of the underlying properties were sold and were bought in by the bondholders' committee, and have been vested in the American Woodworking Machinery Company, which company was incorporated in the State of Pennsylvania for the purpose of acquiring and operating the said properties.

"The policy of the new company is to concentrate its manufacture. To that end some plants will be dismantled and sold. One of the plants which it was contemplated to dismantle and close, as above indicated, was the Goodell & Waters plant, of Philadelphia, to which your article refers. That plant represented less than 4 per cent. of the company's manufacture. The class of machinery manufactured at the Goodell & Waters plant has been, and is now, being manufactured in the company's other plants. The volume of the company's business suffers in no way, but, instead, is decidedly benefited by the sale of the Goodell & Waters plant. . . .

"The writer may say, further, for your information that the American Woodworking Machinery Company is abundantly capitalized upon a cash basis, is enlarging its plants which it proposes to operate and is re-equipping them with the most approved machine tools and appliances for economy and improvement in construction and for that enlarged business which it has developed; that the company is in a highly prosperous condition, and, instead of contemplating disposal of plants in a sense of curtailing its business, its purpose is to increase facilities so as to greatly enlarge and perpetuate its business. . . ."

CHICAGO MACHINERY MARKET.

It is estimated that there will be at Chicago a market for steam engines to the extent of 100,000 horse-power just as soon as the question of the extension of the street-railway franchises is settled. The street railway companies do not care to go ahead with important improvements they have in prospect until their future status is determined. Meanwhile the street-railway business is growing so rapidly that present power is heavily overloaded on all the railways and the limit has about been reached. To bridge over the difficulty the railway people are trying to borrow engine capacity temporarily. Both the surface and elevated lines are consuming their maximum power and both must be extensive purchasers of power at an early date. Inquiries for power are very large and the general opinion from the respective outlooks is that 1902 will be a better year than was 1901.

There is a good demand for pumping machinery, among recent purchasers being the cities of Chicago and Boston. Blowing engines also are quite actively sought, the steel properties being among the more needy buyers. There have been large transactions of that description of late in the Pittsburgh region and the Birmingham (Ala.) district is also a live seeker for blowers. The miscellaneous manufacturing trade presents much business to view for the engine builders, to be placed between now and next spring. A fair business in engines was transacted during the holidays and a volume perhaps not quite so fair since the turn of the year. The year starts off quite moderately in fact, but there is no end to the inquiries in sight.

Gas engines are well to the front in point of activity. Representatives of makers here uniformly report a brisk inquiry and good sales for all sizes. J. R. Detweiler has one inquiry for three 650 horse-power Standard Automatic gas engines and another inquiry for two 1,000 horse-power and one 500 horse-power gas engines, with good prospects that they will soon be closed. In Chicago locally a considerable number of gas engines are taking the place of motors supplied by "current" electricity.

The Colorado Fuel & Iron Company has bought from the Allis-Chalmers Company another mill engine of about 2,000 horse-power for Pueblo delivery. A. L. Ide & Co. have sold two 200 horse-power engines to the Burlington road for the operation of an eight-mile electric branch extending from Deadwood to Leeds, S. D. The boiler trade is active, correspondingly with that of engines. Among recent orders of the Oil City Boiler Works is a 250 water-tube boiler for the Detroit Lubricator Company and two of 125 horse-power each to the Crystal Ice Company, of Paragould, Ark.

One prominent wood-working machinery company has decided against any present enlargements of the works on the ground of a falling off in foreign trade.

Quotations.

NEW YORK, Monday, Jan. 13.

Pennsylvania Foundry Pig Iron, Jersey City delivery:

No. 1 X	$17 15 @ $17 65
No. 2 X	16 65 @ 17 15
No. 2 plain	16 15 @ 16 65
Gray forge	15 25 @ 15 75

Alabama Pig, New York delivery:

No. 1 foundry, or soft	16 25 @ 16 50
No. 2 foundry, or soft	15 75 @ 16 00
No. 3 foundry	15 25 @ 15 50
Foundry forge, or No. 4	14 75 @ 15 00

Bar Iron—Base sizes—Refined brands, mill price on dock, 1.68c. in carload lots. From store, some are willing to quote as low as 1.90c., but 1.95 @ 2.00c. is stated to be the general price.

Tool Steel—Base sizes—Good standard quality, 7c.; extra grades, 10c. and upward.

Machinery Steel—Base sizes—1.90 @ 2.00c. from store.

Cold Rolled Steel Shafting—Base sizes—From store, 2¼ @ 2½c.

Copper—Lake ingot, 11⅛ @ 11½c.; electrolytic, 11 @ 11⅛c.; casting, 11c.

Pig Tin—In 5- and 10-ton lots f. o. b., New York, 22¼ @ 22½c..

Pig Lead—For wholesale lots, 4c., with .02½ @ .05c. extra for carloads.

Spelter—4.30 @ 4.40c. for ordinary quality, New York delivery.

Antimony—Cookson's, 10¼ @ 10½c.; Hallett's and U. S., 8¼ @ 8⅜c.; Italian, 7¾ @ 8c.

Lard Oil—Prime City, 80 @ 82c. in wholesale lots.

New Corporations.

New Jersey Locomotive Co., Paterson, N. J.; object, manufacturing locomotives, etc.; capital, $100,000. Incorporators: Alfred L. Curtiss, J. Clinton Walker and Fred W. Cooke.

Marshall-Wells Hardware Co.; capital, $2,000,000. Incorporators: Thomas J. Davis, Theodore Hollister, Frank Hicks, C. S. Tremelling and E. A. Hicks, all of Jersey City, N. J.

Shaw Electrical Co., 419 Market street, Camden, N. J.; manufacturing electrical devices; capital, $50,000. Incorporators: J. Elliott Shaw, Wm. Gibson, George H. B. Martin.

A certificate of incorporation has been filed in Delaware for the Kingsley Patent Boiler Co., of New York (capital, $1,250,000), to manufacture and sell boilers and other machinery.

Columbia Clock Co., 525 Main street, East Orange, N. J.; object, manufacturing electrical movements of all kinds; capital, $125,000. Incorporators: C. V. Childs, Jas. R. Mapletoft, H. N. Smith.

American Brick Machinery Co., 243 Washington street, Jersey City, N. J.; object, manufacturing brick machinery; capital, $100,000. Incorporators: Edward Cole, Geo. H. Bontecon and Axel V. Becker.

International Marine Governor Co.; principal office, Mt. Holly, N. J.; object, manufacturing machinery; capital, $1,000,000. Incorporators: Joseph Rowell, Wm. S. Randell, C. Foster Cox and others.

E. P. Holden Machinery Co.; principal office, 419 Market street, Camden, N. J.; object, manufacturing machinery, etc.; capital, $500,000. Incorporators: Geo. H. B. Martin, Wm. F. Eidell, John A. MacPeak.

Automat Co. of America; principal office, 419 Market street, Camden, N. J.; object, manufacturing automatic machines; capital, $250,000. Incorporators: Frank Hardart, Alfred H. Lippincott, Joseph V. Horn.

Jackson Typewriting Machine Co.; principal office, 525 Main street, East Orange, N. J.; object, manufacturing typewriting machines, etc.; capital, $500,000. Incorporators: Alfred G. Brown, Albert R. Palmer and John R. Turner.

Hird Cushion Tire Co.; principal office, the Corporation Trust Company Building, 15 Exchange place, Jersey City, N. J.; object, manufacturing tires, etc.; capital, $200,000. Incorporators: Louis B. Dailey, Clifford W. Perkins and Aug. O. Meeker.

Bourne & Co., Ltd.; principal office, Second and Trumbull streets, Elizabeth, N. J.; object, buying, selling and manufacturing sewing machines; capital, $100,000. Incorporators: Frederick G. Bourne, William F. Proctor, D. Alexander and others.

Pacific Hardware & Steel Co., 419 Market street, Camden, N. J.; object, manufacturing hardware, etc.; capital, $10,000,000. Incorporators: Augusta K. Gibbs, E. A. Selfridge, Chas. E. Miller, H. J. Morton, Louis Sloss, Jr., A. L. Scott, Joseph Sloss, D. H. Kane.

McWhorter Manufacturing Company; principal office, Blackwood, Camden Co., N. J.; object, manufacturing agricultural implements; capital, $60,000. Incorporators: Francis S. McWhorter, Wm. A. McWhorter, Samuel A. Hendrickson, Wm. A. Hendrickson.

New Catalogs.

The Robbins & Myers Company, Springfield, O., is sending on application a new pamphlet about its protected type, direct-current dynamos and motors, which concisely states the points necessary to buyers. It is 8x10 inches in size.

The Link-Belt Engineering Company, Nicetown, Pa., has published a little pamphlet (3½x6 inches, standard size) illustrating and describing the mechanism and utility of the Renold high speed silent driving chains, which, as we have already announced, the company is now manufacturing in this country.

The C. W. Hunt Company, West New Brighton, Staten Island, has published a new pamphlet, No. 0117, on its steam hoisting engines, which explains the merits of their construction in a specific and interesting manner. No. 0115, relating to electric hoists, also comes to hand. Each pamphlet is 6⅝x9¼ inches.

Henry Disston & Sons, Philadelphia, Pa., have published a 1902 price list which sets forth their extensive line of saws in imposing array. There is also shown an assortment of tools and machines for gumming, chambering, sharpening and repairing saws, besides a line of wire gages, files, rasps, etc. The catalog is 7x10 inches.

We have received a set of the sectional pamphlets in which the E. W. Bliss Company, Brooklyn, N. Y., conveniently catalogs its products. Among the several topics are "Bliss" inclinable power presses, "Stiles" power punching presses, "Bliss" straight-sided power presses, drop hammers and trimming presses, drawing presses and spinning lathes, "Bliss" foot and screw presses. The general size of these booklets is 5x7 inches.

The Triumph Electric Company, Cincinnati, O., has sent us some pamphlets describing its generators and motors. One is a handsome pamphlet showing the construction of the armature, magnets, etc., in detail and also motor applications to machines from an egg-beater to a double punch and shear. Another publication relates to direct-connected generators of engine and marine types; a third to belted generators and motors of slow and moderate speed. These pamphlets are 9¾x6¾ inches.

Manufacturers.

The Lebanon (Pa.) Boiler Company has begun the construction of a new shop.

A factory building is to be erected for the Bagby Furniture Company, Baltimore, Md.

The Moore Bros., Wichita, Kan., will build an addition to their foundry and stove works.

A four-story factory will be built in Long Island City, N. Y., for the Cook Electric Company.

The Fiberoid Company of Newburyport, Mass., proposes to erect a number of new buildings.

Stanley G. Flagg & Co., iron founders, Philadelphia, Pa., will enlarge their plant at Pottstown.

An ice-manufacturing plant will be erected for the Kansas Ice & Storage Company at Salina, Kan.

The People's Ice & Coal Company is to build a plant in Findlay, O., at an estimated cost of $50,000.

Plans are being prepared for an addition to the plant of the United Illuminating Company, Bridgeport, Conn.

Work has been commenced on a new foundry of the Novelty Stove & Manufacturing Company, Savannah, Mo.

The Union Steam Pump Company, Battle Creek, Mich., is increasing its capital stock from $250,000 to $285,000.

An addition is being added to the power-house of the Camden (N. J.) & Suburban Railway along Cooper Creek.

A new factory building is to be erected in Waterbury, Conn., for the Waterbury Farrel Foundry & Machine Company.

David H. Stroud, 2813 American street, Philadelphia, Pa., will build a new $15,000 factory for manufacturing rugs.

An addition is being erected to the works of the Cleveland Worsted Mills Company, No. 1742 Broadway, Cleveland, O.

The A. W. Cadman Manufacturing Company, Pittsburgh, Pa., is in the market for a 25 or 30 horse-power gas engine.

The Lehigh Valley & Philadelphia Traction Company has decided to locate its central power station at Sellersville, Pa.

The Hard Manufacturing Company, maker of wire mattresses, Buffalo, N. Y., has planned to put up a $39,000 factory building.

James F. Malloy & Co., manufacturers of buckles, New Haven, Conn., are building an addition to their factory on Grant street.

The American Sheet Iron Company has awarded the contract for the erection of an addition to its plant at Phillipsburg, N. J.

The Locke Insulator Works at Victor, Ontario County, N. Y., have largely been burned. It is stated that they will be rebuilt at once.

The Osmun Manufacturing & Building Company is being organized at Pontiac, Mich., to manufacture bricks and building materials.

Tate, Jones & Co., Pittsburgh, Pa., have contracted to furnish a 2,000 horse-power rope drive to the La Belle Iron Works, Wheeling, W. Va.

It is stated that the New Berlin Bridge Company, New Berlin, Conn., has purchased ground near Sewickley, Pa., on which it will build a plant.

The Columbia Water Company, Columbia, Pa., is having plans prepared for the erection of a filter plant to have a daily capacity of 2,000,000 gallons.

Work has been commenced on the new plant of the National Foundry Company at Sharon, near Cincinnati, O. C. C. Robinson will be the general manager.

The Cadwallader Tin Plate & Metal Company, Pittsburgh, Pa., is a new organization, formed by Geo. A. Cadwallader, F. H. Good, Samuel Hunt and others.

The Redding Engineering Company, Pittsburgh, Pa., has recently commenced the manufacture and installation of power and pumping machinery, valves and fittings.

The R. Herschel Manufacturing Company, mower knives, etc., Peoria, Ill., will probably put up a 180x120-foot factory. One feature will be a 300 horse-power engine.

The "Omaha" Railway Company will spend about $30,000 in the construction of a new shop at Hudson, Wis., for the construction and repair of passenger equipment.

In Franklin, N. H., it is stated that the Boston Excelsior Company is negotiating for the purchase of Eastman's Falls for the purpose of constructing a dam and an excelsior mill.

The Sharon (Pa.) Coke Company is preparing plans for the erection of a modern by-product plant. It will consist of 312 ovens, and will have a capacity of about 1,200 tons daily.

The Fred Macey Company, Ltd., office furniture manufacturer, Grand Rapids, Mich., has taken out the permit for a factory, the estimated cost of construction of which is $95,000.

It is reported from Chester, Pa., that the Guffey Petroleum Company will erect a $1,000,000 refinery, in which a new process, evolved by W. H. Warren, will be put in operation.

It is rumored that the Louisville & Nashville Railroad shops at New Decatur, Ala., are soon to be enlarged again and that the company is figuring on manufacturing its own axles there.

New furnaces, a tramway and other improvements are being made to the plant of the Damascus Bronze Company, Allegheny, Pa., which will give an increased capacity of 50 per cent.

The Willingham Cotton Mills Corporation, Macon, Ga., has increased its capitalization to $150,000 from $100,000. The object is to make extensive improvements in and additions to the plant.

The Youngstown Steel Casting Company, Youngstown, O., has organized by the election of E. B. Lawrence, president; T. B. Van Alstine, vice-president; John W. Rogers, secretary and treasurer.

Harrison Brothers, of Philadelphia, Pa., are interested in the development of bauxite in Floyd County, Ga. It is said that they contemplate the erection of a $100,000 reduction plant near Rome.

The Keystone Foundry Company, Uniontown, Pa., will double the capacity of its plant in the near future. A building, 75x150 feet, will be added to the plant, to be used as a radiator department.

A paper pulp and sugar plant is to be erected at Wichita, Kan. A Mr. Dennison is prominently identified with the movement. Twenty thousand dollars' worth of machinery has already been purchased.

It is intended to enlarge the Lancaster (N. Y.) Malleable Iron Works, so as to increase the daily output from less than 20 to about 75 tons. The controlling interest in the company has recently changed hands.

Roberts Brothers, of Baltimore, who for two seasons have operated the plant of the Salisbury (Md.) Canning Company, will erect a canning establishment in Salisbury. The capacity of the plant will be 35,000 to 40,000 cans per day.

Contracts are being awarded for the new plant of the Bradley Manufacturing Company, Pittsburgh, Pa. The works, which will be located on Preble avenue, Allegheny, will be equipped for the manufacture of the Willans central valve engine.

The Dowerman Rivet & Bolt Manufacturing Company, recently organized in Pittsburgh, Pa., has secured quarters at Thirty-second and Smallman streets, where it will manufacture boiler and structural rivets of Bessemer and open-hearth steel.

The Vulcan Machine Company, Wilkesbarre, Pa., were given the contract for two 24x48-inch hoisting engines for the new coke oven plant of the Hecla Coke Company in Mt. Pleasant Township, Pa. Wm. G. Wilkins, Pittsburgh, was the engineer.

It is reported that William R. Dougherty, Philadelphia, Pa., has been awarded the contract for the erection of a power-house at Woodbine, N. J., for the Woodbine Land & Improvement Company. Plans are by Samuel Hall Day, architect, of New York.

Mr. Arrowsmith, of the Arrowsmith Electric Company, Ltd., Reading, Pa., will be the prime mover in the Electric Alliance Company, for which a plant is being equipped. Herman Slichter will be the manager. Various electric appliances will be manufactured.

The Magnetite Foundry Company, St. Louis, Mo., has recently taken on some large contracts which, with previously secured orders for castings for forward delivery, practically take up the capacity to April 1. The company is, however, contemplating further additions to its plant.

The Republic Iron & Steel Company is considering the erection of a large steel plant at Thomas, in the Birmingham (Ala.) district. The Sloss-Sheffield Steel & Iron Company and the Tennessee Coal, Iron & Railroad Company propose to make important extensions in their operations.

The Miami Concrete & Stone Company, recently organized with a capital stock of $100,000 by A. L. Irish, J. P. McAfee, Fred E. McCaskey, George Robertson and George G. Metzger, expects to place about $50,000 worth of new machinery in the plant to be installed at Waterville, O.

It is stated that the Sharon (Pa.) Steel Hoop Company will shortly begin work on additions and improvements to its plant that will cost about $1,000,000. The company intends to build its own open-hearth steel plant and two additional mills for the manufacture of steel hoops and cotton ties.

The Vulcan Manufacturing Company, Pittsburgh, Pa., and the Fullman Company, same place, have consolidated their interests under the name of the Fullman Company. Offices and works will be established in the Imperial Power Building, where a general line of electrical engineering and designing, machinists' tool making, etc., will be carried on.

The American Machine Company, Louisville, Ky., has the foundation almost complete for its new shop. The plant will consist of machine shop, 50x150 feet, 40 feet high, fitted with power traveling cranes, first and second stories, also gib cranes. To the present outfit of machinery will be added one 72-inch Niles full universal radial drill, one special 72-inch Niles horizontal boring and turning mill, one keyseat slotting machine, several small drill presses and several small lathes. The smith shop will be 25x50 feet, equipped with hand, traveling and gib cranes, one steam hammer, bolt threading machine, punch, shears, bending rolls, blast fans—all to be driven with electric motors. The foundry will be 45x150 feet, equipped with power traveling crane, cupola, 5 tons capacity; blast fan, casting mill. The wood shop will be two and a half stories, 68x100 feet, equipped with planer, jointer, cross and rip saws, boring and turning machine, band saw and wood lathe. The plant will be operated by one Houston, Stanwood & Gamble 75 horse-power engine and one 100 horse-power horizontal tubular boiler. The entire plant will be heated with steam. The lighting plant will be direct connected and of about 20 kilowatts capacity. The company would be pleased to receive quotations on all material mentioned, except boiler, engine, radial drill and boring mill, for which they have placed their order.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Gear Wheels, gear cutting. Grant; see p. 18.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Punches & dies. Wal.M.Wks., Waltham, Mass.

Wanted—Improvements in grinding machinery. Address Box 1435, Providence, R. I.

For Sale—British rights of rolled thrust vise. Address "Vise," AMER. MACHINIST.

Fine mahine and experimental work. The Des Jardins Type Justifier Co., Hartford, Ct.

Light and fine mach'y to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Special tools, models, fine light mach'y and foundry work wanted. Murray Mfg. Co., Richmond Valley, Staten Island, N. Y.

Wanted—Small machine for graduating cylindrical spindles; second hand preferred. "Capacity," care AMERICAN MACHINIST.

Wanted—Partner who understands construction of gas engines and has some capital. "Hustler," care AMER. MACHINIST.

A middle-aged man, with 18 years' experience in the office and selling end of a manufacturing business, wishes to purchase an interest in and associate himself with a small manufacturing business. Box 316, AM. MACH.

Purchaser for small manufacturing plant: lot, 100x180 feet; machine shop, 32x68, two story, with line shaft and gasoline power; foundry, 40x54, new modern equipment; good location; for sale cheap. Hart-Parr Co., Madison, Wis.

Foundry in eastern Pennsylvania, making a specialty of machinery castings, would like to make contract with machinery manufacturing concern for furnishing strictly high-grade castings at lowest figure. Address "Foundry," care AMERICAN MACHINIST.

Institutions retiring from business having machine tools, brass and wood working machinery will find it to their interest to correspond with us. We purchase complete plants or handle them on com. C. C. Wormer Mach. Co., 55-59 Woodbridge st., W., Detroit, Mich.

Wanted—Partner with capital, mental comprehension and "enterprise," to engage in lucrative business, foundry and machine shop, central New York; excellent railroad shipping facilities; good field for repair work; saleable products to manufacture; opportunity for earnest man desiring business of magnitude. Address "Experienced Mechanic," Box 49, AMERICAN MACHINIST.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded; but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value

should not be enclosed to unknown correspondents.

Situations Wanted.

Competent machine shop foreman desires change; A1 references. Box 52, AM. M.

Experienced draftsman, technical graduate, wants position. Box 64, AMER. MACHINIST.

Bookkeeper, 20; card system; thoroughly proficient; A1 reference. Box 62, AM. MACH.

Thoroughly competent man desires position as chief engineer of power station. Box 43, AMERICAN MACHINIST.

Foreman patternmaker desires a change; can save salary with 10 or more men. Box 65, AMERICAN MACHINIST.

Superintendent, experienced in manufacture of dynamos, motors, arc lamps, tools, etc., desires engagement. Box 35, AMER. MACH.

Mechanical engineer, 26, graduate of Sweden, with 4 years' experience, wants position as assistant superintendent. Box 63, AM. M.

Foreman brass finisher desires engagement; up in all branches for marine, sugar-house and chemical work; best of references. Address "Brass," care AMERICAN MACHINIST.

Designer, expert draftsman, wants responsible position; experienced in printing presses, paper bag, metal forming and fine automatic machinery. Box 55, AMERICAN MACHINIST.

Designing draftsman desires permanent position with progressive firm; 12 years' experience; well up in all details of modern shop practice. Box 53, AMER. MACHINIST.

Mechanical engineer and draftsman, practical man, to lay out and superintend erection foundry, steam plants and general work, open for engagement February 1. Box 20, AM. M.

Expert designer, 28; experienced in gasoline and steam autocars, automatic machinery, printing presses, ice machines, etc.; shop experience; technical graduate. Box 61, A. M.

Practical machine designer, technical graduate with shop knowledge, 10 years' experience intricate automatic machinery and tools, light and heavy, wishes to change. Box 51, AMERICAN MACHINIST.

Mechanical engineer, university graduate, 3 years' shop, 2 years' business and 6 years' board experience, competent designer and draftsman, linguist, seeks change. Box 66, AMERICAN MACHINIST.

Graduate of M. I. T., with 7 years' practical experience, now head draftsman cotton manufacturing and printing company, seeks responsible engineering position; refers to present employers. Box 33, AMERICAN MACHINIST.

Toolmaker, machinist and draftsman, 39, experienced experimenter and thoroughly familiar with the manufacture of small and medium machinery, employed in New York at present, wishes to make a change. Box 68, AMERICAN MACHINIST.

A designing draftsman and practical machinist, with 18 years' experience in the mechanical engineering line, desires position as mechanical superintendent or chief draftsman; salary not less than $30 per week. Box 54, AMERICAN MACHINIST.

Situation as superintendent or general foreman, by practical machinist; wide experience as workman and in charge of shops; fine executive; good manager of men; finest reference; will go anywhere to advance his interest. Box 67, AMERICAN MACHINIST.

Wanted—Position as blacksmith foreman; light or heavy forgings; thoroughly understand handling men; well up in designing tools for the economical production of work; 12 years experience as foreman; A1 references. Box 50, AMERICAN MACHINIST.

Man of 14 years' experience on small interchangeable work, including apprenticeship with one of the most prominent concerns in the country and in positions of responsibility, is open for position as foreman or assistant to superintendent; A1 reference. Box 56, AMERICAN MACHINIST.

Situation wanted in brass or copper rolling mill, as foreman or assistant foreman, by a young man who has had 8 years' experience in rolling mill work; references from former and present employers; not particular as to location of mill. Address Chas. E. Moore, 1352 Fairfield ave., Bridgeport, Conn.

Machine shop foreman, at present employed, wishes to make a change; 12 years in present position handling from 75 to 100 men on large engine work; would like position with a firm building marine or waterworks engines; first-class references if required. Address "Marine," care AM. MACH.

Help Wanted.

Wanted—First-class toolmaker and one machinist. Address Day Mfg. Co., Lake View, N. Y., for 30 days.

Wanted—Competent draftsmen with broad experience in machine tool designing. The American Tool Works Co., Cincinnati, O.

Machinists wanted, first-class floor men, $2.35 per day, in 9-hour shop, 1 hour from New York. Address Box 57, AMER. MACH.

Wanted—Mechanical draftsman; one familiar with mining machinery; state salary expected. Address M. F. L., AMER. MACHINIST.

Draftsman wanted; detail designer and first-class tracer on sawmill and compressed air work. Curtis & Co. Mfg. Co., St. Louis, Mo.

Wanted—By Struthers, Wells & Co., Warren, Pa., a first-class assistant foreman for boiler shop; write at once for particulars, stating experience, etc.

Wanted—First-class foreman for machine shop; must have first-class references; a Western mechanic preferred. Address Box 60, AMERICAN MACHINIST.

Wanted—Number of patternmakers, experienced on compressor or steam engine work; none others need apply. Franklin Air-Compressor Co., Franklin, Pa.

Draftsman.—Wanted—A first-class mechanical draftsman, good detailer, for motor carriage work. Reply, giving full particulars, to Box 58, AMERICAN MACHINIST.

Turret lathe foreman wanted, with experience on Gisholt and Jones & Lamson machines, capable of getting out special tools for same. Box 31, AMERICAN MACHINIST.

Wanted—Draftsman, familiar with machine tools, to work on details; steady employment to right man. Apply, stating age, experience, salary expected, Box 18, AM. M.

Wanted—A good detail draftsman with experience in locomotive work; must be quick and accurate; state age, experience and salary. Apply to The Canadian Locomotive Company, Limited, Kingston, Canada.

Wanted—A good machinist who can take charge of machine shop in a bridge works and who understands electrical repair work. Address "A.," care AMERICAN MACHINIST, giving experience, recommendations and wages expected.

We are enlarging our works, and will shortly require an increased number of skilled mechanics; we invite application from pattern makers, molders and machinists. Address the Westinghouse Machine Company, East Pittsburgh, Pa.

Wanted—First-class mechanical engineer, experienced in the design of electrical machinery, to go to Europe; none but experienced, first-class men need apply; suitable man will be paid a high salary. Address Box 69, AMERICAN MACHINIST.

Wanted—Foreman to take charge of machine shop in western Pennsylvania, manufacturing gears and machinery; must be experienced and up to date; state salary expected; position permanent, with opportunity for advancement. Box 32, AMERICAN MACHINIST.

Wanted—Foundry foreman; machine tool and light work; employing about 40 molders; must be a good mechanic; good manager; able to secure results and make good work; state age, experience, references, salary and full particulars. Box 41, AMER. MACHINIST.

Wanted—Foreman machinist, thoroughly familiar with the manufacture of pneumatic hammers; he must be capable of handling men and machines to get out work up to date; steady work and good pay to right man; state age and references. Address Box 40, AM. M.

Wanted—Thoroughly competent foreman on machine tool building, experienced in building pipe threading machinery, familiar with methods of producing duplicate parts on turret lathes; give age, experience, salary expected and references. Box 28, AMER. MACH.

Wanted—A young man, experienced in office work, familiar with machine tool business or from export house, with knowledge of manufacturers of tools and machinery; must write good hand and be familiar with keeping costs and entering orders; good position to right person. Address Box 59, AM. MACH.

Wanted—A first-class patternmaker to work at the bench and have general supervision over the pattern shop; position in a Southern city of 20,000 inhabitants; new modern shop now being erected; a permanent place for the right man; good wages and good treatment guaranteed. Box 8, AMER. MACH.

We are erecting new shop buildings and equipping same with all modern appliances; will shortly require an increased number of skilled mechanics; we invite application from machinists, boilermakers and patternmakers; good references must be furnished as to ability and habits. Address Southern Engine & Boiler Works, Jackson, Tenn.

Wanted—Superintendent, by a leading Canadian company, manufacturing pumping machinery; about 150 hands; must be a man of exceptional ability, able to organize all departments and force production; experience in our line necessary; young man preferred; state age, experience, salary required; send testimonials. Apply "Toronto," care AM. MACH.

Wanted—A mechanical engineer as foreman, by a concern manufacturing high and medium speed automatic engines, also plain slide valve engines, to take full charge of this department; applicant must have first-class ideas and executive ability in handling men; the factory manufactures engines exclusively; give age, address and references. Box 27, AMERICAN MACHINIST.

Wanted—Boiler shop foreman, capable of taking charge of shop working from 75 to 100 men at present and will build new plant during the coming year; must have experience in construction of locomotive boilers and tank work, also the use of hydraulic and air tool equipment of the latest design; a first-class position for the proper party. Address "Locomotive Works," care AMERICAN MACHINIST.

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Balls, Steel
Automobile & Cycle Parts Co., Cleveland, O.
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Bearing Metal
Phosphor Bronze Smelting Co., Ltd., Philadelphia, Pa.

Belt Dressing
Jos. Dixon Crucible Co., Jersey City, N. J.

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Belt Lacing Machines
Diamond Drill & Mach. Co., Birdsboro, Pa.

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Blue Printing Machines
Pittsburgh Blue Print Co., Pittsburgh, Pa.

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Blowers
Am. Gas Furnace Co., N. Y. City.
Buffalo Forge Co., Buffalo, N. Y.

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Struthers, Wells & Co., Warren, Pa.

Bolt and Nut Machinery
Acme Mchry. Co., Cleveland, O.
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Books, Mechanical
Audel & Co., Theo, New York.
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Boring and Turning Mills
Am. Tool Wks. Co., Cincinnati, O.
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The Beaman & Smith Co., Providence, R. I.
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Rand Drill Co., New York.

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Am. Gas Furnace Co., N. Y. City.

Gear Cutting Machinery
Bickford Drill & Tool Co., Cin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Fellows Gear Shaper Co., Springfield, Vt.
Gould & Eberhardt, Newark, N. J.
Harrington & Son Co., Edwin, Philadelphia, Pa.
Newton Mch. Tool Wks., Phil., Pa.
Pratt & Whitney Co., Hartford, Conn.

Gears, Cut
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Wks., Boston, Mass.
Cleveland Gear Wks., Cleveland, O.
Fawcus Mach. Co., Pittsburgh, Pa.
Gleason Tool Co., Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott, Cleveland, O.
New Process Raw Hide Co., Syracuse, N. Y.
N. Y. Gear Works, Brooklyn, N. Y.
Nuttall Co., R. D., Pittsburgh, Pa.
Turley, J. G., St. Louis, Mo.

Gears, Molded
Farrel Fdry & Mch. Co., Ansonia, Conn.
Greenwald Co., I. & E., Cincin., O.
Poole & Son Co., Robt., Baltimore, Md.

Gears, Rawhide
Boston Gear Wks., Boston, Mass.
Chicago Raw Hide Co., Chicago, Il.
New Process Raw Hide Co., Syracuse, N. Y.

Graphite
Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Center
Heald & Son, L. S., Barre, Mass.
Leland & Faulconer Mfg. Co., Detroit, Mich.

Grinders, Cock
Windsor Mach. Co., Windsor, Vt.

Grinder, Cutter
Adams Co., Dubuque, Iowa.
Cincinnati Milling Mach. Co., Cincinnati, O.
Garvin Mach. Co., New York.
Gould & Eberhardt, Newark, N. J.
Modern Tool Co., Erie, Pa.
Norton Emery Wheel Co., Worcester, Mass.
Rivett-Dock Co., Boston, Mass.

Grinders, Disc
Gorton Mach. Co., Geo., Racine, Wis.
Ransom Mfg. Co., Oshkosh, Wis.
Universal Mach. Co., Provi., R. I.

Grinders, Drill
Gorton Mach. Co., Geo., Racine, Wis.
Heald & Son, L. S., Barre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Tool
Anderson Tool Co., Anderson, Ind.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Gisholt Mach. Co., Madison, Wis.
Landis Tool Co., Waynesboro, Pa.
Leland & Faulconer Mfg. Co., Detroit, Mich.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, O.
Whitney Mfg. Co., Hartford, Ct.

Grinders, Saw
Keystone Mach. Tool Wks., Philadelphia, Pa.

Grinding Wheels
Abrasive Material Co., Phila., Pa.
Builders' Iron Foundry, Providence, R. I.
Carborundum Co., Niagara Falls, N. Y.
Hampden Cor. Wheel Co., Brightwood, Mass.
Norton Emery Wheel Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.

Grinding Machines
Anderson Tool Co., Anderson, Ind.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders' Iron Foundry, Providence, R. I.
Gorton Mach. Co., Geo., Racine, Wis.
Hill, Clarke & Co., Boston, Mass.
Landis Tool Co., Waynesboro, Pa.
Northern Elec. Mfg. Co., Madison, Wis.
Norton Emery Wheel Co., Worcester, Mass.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, Mass.
Universal Mach. Co., Provi., R. I.
Webster & Perks Tool Co., Springfield, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Gun Barrel Machinery
Pratt & Whitney Co., Hartford, Ct.
Reed Co., F. E., Worcester, Mass.

Hack Saw Blades and Frames
Millers Falls Co., New York.
Starrett Co., L. S., Athol, Mass.
West Haven Mfg. Co., New Haven, Conn.

Hack Saws, Power
Hoefer Mfg. Co., Freeport, Ill.

Hammers, Drop
Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Merrell Bros., Brooklyn, N. Y.
Niles-Bement-Pond Co., New York.
Perkins Mach. Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Ct.

Hammers, Steam
Chambersburg Engineering Co., Chambersburg, Pa.
Cleveland Punch & Shear Wks Co., Cleveland, O.
Niles-Bement-Pond Co., New York.

Hammers, Pneumatic
Cleveland Pneumatic Tool Co., Cleveland, O.
Dallett & Co., Thos. H., Phila., Pa.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Standard Pneumatic Tool Co., Aurora, Ill.

Handles, Machine Tool
Norwood Bicycle Co., Cincin., O.
Schacht Mfg. Co., Cincinnati, O.

Heating Machines, Automatic
Am. Gas Furnace Co., 23 John st., N. Y. City.

Heating and Ventilating Apparatus
Buffalo Forge Co., Buffalo, N. Y.

Hoists, Electric
C & C Electric Co., New York.
Hunt Co., C. W., West New Brighton, N. Y.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger, Milwaukee, Wis.

Hoists, Hand
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic
Cleveland Pneumatic Tool Co., Cleveland, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Northern Engineering Wks., Detroit, Mich.
Rand Drill Co., New York.
Standard Pneumatic Tool Co., Aurora, Ill.

Hoisting and Conveying Machinery
Brown Hoisting Mchry. Co., New York.
Caldwell & Son Co., H. W., Chicago, Ill.
Hunt Co., C. W., West New Brighton, N. Y.
Link Belt Engine Co., Phila., Pa.

Indicators, Steam
Crosby Steam Gage & Valve Co., Boston, Mass.

Injectors
Lunkenheimer Co., Cincinnati, O.
Sellers & Co., Wm., Phila., Pa.

Inspection and Tests
Hunt Co., Robt. W., Chicago, Ill.

Instruments, Drawing
Alteneder & Son, Theo., Philadelphia, Pa.

Insurance, Boiler
Hartford Steam Boiler Insp. & Ins. Co., Hartford, Conn.

Jacks, Hydraulic
Watson-Stillman Co., New York.

Joints, Universal
Baush Machine Tool Co., Springfield, Mass.

Key Seaters
Baker Bros., Toledo, O.
Chattanooga Mchy. Co., Chattanooga, Tenn.
Mitts & Merrill, Saginaw, Mich.

Keys, Machine
Standard Gage Steel Co., Beaver Falls, Pa.
Whitney Mfg. Co., Hartford, Ct.

Lamps, Arc
General Electric Co., N. Y City.
Gen. Incan. Arc Light Co., N. Y.
Lea Elec. Mfg. Co., Anderson, Ind.
Western Electric Co., Chicago, Ill.

Lathes, Bench
Faneuil Watch Tool Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Ct.

Lathe Dogs
Armstrong Bros. Tool Co., Chicago, Ill.
Hill Tool Co., Anderson, Ind.
Le Count, Wm. G., So. Norwalk, Conn.

Lathe Feed
Nat'l. Mach. Tool Co., Cincin., O.

Lathes
American Tool Wks. Co., Cin., O.
Automatic Mach. Co., Bridgeport, Conn.
Baird Machy. Co., U., Pittsburgh, Pa.
Barker & Chard Mach. T. Co., Cincinnati, O.
Barnes Co., B. F., Rockford, Ill.
Barnes, W. F. & John, Rockford, Ill.
Blaisdell & Co., P., Worcester, Mass.
Bradford Mach. Tool Co., Cin., O.
Bullard Mach. Tool Co., Bridgeport, Conn.
Fairbanks Mch. Tool Co., Springfield, O.
Flather Planer Co., Mark, Nashua, N. H.
Garvin Mach. Co., New York.
Grant Tool Co., Franklin, Pa.
Greaves, Klusman & Co., Cincinnati, O.
Harrington, Son & Co., Edwin., Philadelphia, Pa.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
McCabe, J. J., New York.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Reed Co., F. E., Worcester, Mass.
Schumacher & Boye, Cincinnati, O.
Sebastian Lathe Co., Cincin., O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Shepard Lathe Co., Cincin., O.

Levels
Starrett Co., L. S., Athol, Mass.

Lockers, Clothes
Merritt & Co., Philadelphia, Pa.

Locomotives, Shop
Hunt Co., C. W., West New Brighton, N. Y.

Lubricants
Dixon Crucible Co., Jos., Jersey City, N. J.

Lubricators
Bowen Mfg. Co., Auburn, N. Y.
Lunkenheimer Co., Cincinnati, O.

Machinery Builders, Special
Blanchard Mach. Co., The, Boston, Mass.
Watson Mach. Co., Paterson, N. J.

Machine Screws
Worcester Mach. Screw Co., Worcester, Mass.

Machinists' Small Tools
Billings & Spencer Co., Hartford, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hammacher, Schlemmer & Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Ct.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb & Co., J. T., Provi., R. I.
Standard Tool Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.

Mandrels, Expanding
Nicholson & Son, W. H., Wilkesbarre, Pa.

Mandrels, Solid
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Rogers, John M., Boat, Gage & Drill Works, Gloucester City, N. J.

Measuring Machines
Pratt & Whitney Co., Hartford, Ct.
Rogers, John M., Boat, Gage & Drill Works, Gloucester City, N. J.

Micrometer Calipers
Brown & Sharpe Mfg. Co., Providence, R. I.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb & Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Milling Attachments
The Adams Co., Dubuque, Iowa.
Cincinnati Milling Mach. Co., Cincinnati, O.
Kempsmith Mfg. Co., Milwaukee, Wis.

Milling Machines, Bench
Faneuil Watch Tool Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Ct.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Plain
American Tool Wks. Co., Cin., O.
Aurora Tool Works, Aurora, Ind.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mach. Co., Cincinnati, O.
Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Kempsmith Mfg. Co., Milwaukee, Wis.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Whitney Mfg. Co., Hartford, Ct.

Milling Machines, Portable
Underwood & Co., H. B., Philadelphia, Pa.

Milling Machines, Heavy Horizontal
Adams Co., Dubuque, Iowa.
Beaman & Smith Co., Provi., R. I.
Franklin Mach. Wks., Phila., Pa.
Grant Tool Wks., Franklin, Pa.
Hendey Mach. Co., Torrington, Ct.
Ingersoll Mill. Mach. Co., Rockford, Ill.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.

Milling Machines, Universal
Amer. Tool Wks. Co., Cincin., O.
Aurora Tool Works, Aurora, Ind.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mach. Co., Cincinnati, O.
Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Kempsmith Mfg. Co., Milwaukee, Wis.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Ct.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Vertical
Clough, R. M., Tolland, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Garvin Mach. Co., New York.
Newton Mach. Tool Wks., Philadelphia, Pa.

Molding Machines
The Adams Co., Dubuque, Iowa.
Tabor Mfg. Co., Philadelphia, Pa.

Motors, Electric
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Eddy Elec. Mfg. Co., Windsor, Ct.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Robbins & Myers Co., Springfield, Ohio.
Sprague Electric Co., New York.
Triumph Elec. Co., Cincinnati, O.
Western Electric Co., Chicago, Ill.

Nut Tappers
See Bolt and Nut Machinery.

Oilers
Bay State Stamping Co., Worcester, Mass.

Oil Cups and Covers
Bowen Mfg. Co., Auburn, N. Y.
Crane Co., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
The Winkley Co., Hartford, Conn.

Packing, Steam Joint
Jenkins Bros., New York.

Patterns, Wood
Gobeille Pattern Co., Cleveland, O.

Patent Solicitors
Baldwin, Davidson & Wight, Washington, D. C.
Bevans, James W., Washington, D. C.
Copp & Co., Washington, D. C.
Cromwell, W. H., Washington, D. C.
Frothingham, N. L., New York.

Pattern Letters
Butler, A. G., N. Y. City.

Pattern Shop Machinery
American Machinery Co., Grand Rapids, Mich.
Baker Bros., Toledo, O.
Fay & Scott, Dexter, Me.
Greaves, Klusman & Co., Cincinnati, O.

Phosphor Bronze
Phosphor Bronze Smelting Co., Philadelphia, Pa.

Pipe Cutting and Threading Machines
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Curtis & Curtis Co., Bridgeport, Conn.
Merrell Mfg. Co., Toledo, O.
Saunders' Sons, D., Yonkers, N. Y.

Pipe Fitters' Tools
Saunders' Sons, D., Yonkers, N. Y.
Standard Tool Co., Cleveland, O.

Pipe and Fittings
Crane Co., Chicago, Ill.

Planer
Armstrong Bros. Tool Co., Chicago, Ill.

Planers
Amer. Tool Wks. Co., Cincin., O.
Belmer-Eames Tool Co., Cin., O.
Betts Mach. Co., Wilmington, Del.
Cincinnati Planer Co., Cincin., O.
Cleveland Punch & Shear Wks. Co., Cleveland, O.
Detrick & Harvey Mch. Co., Baltimore, Md.
Flather Planer Co., Mark, Nashua, N. H.
Garvin Mach. Co., New York.
Gray Co., G. A., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Niles-Bement-Pond Co., New York.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Wks., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Ct.
Sellers & Co., Wm., Phila., Pa.
Whitcomb Mfg. Co., Worcester, Mass.
Woodward & Powell Planer Co., Worcester, Mass.

Planers, Portable
Morton Mfg. Co., Muskegon Heights, Mich.
Underwood & Co., H. B., Philadelphia, Pa.

Planers, Rotary
Franklin Mach. Wks., Phila., Pa.
Keystone Mach. Tool Wks., Philadelphia, Pa.
Newton Mch. Tool Works, Philadelphia, Pa.
Underwood & Co., H. B., Phila., Pa.

Presses, Hand
Elmes Engineering Wks., Chas. F., Chicago, Ill.
Pratt & Whitney Co., Hartford, Conn.

Presses, Hydraulic
Elmes Engineering Wks., Chas. F., Chicago, Ill.
Watson-Stillman Co., New York.

Presses, Power
Bliss Co., E. W., Brooklyn, N. Y.
Perkins Mach. Co., Boston, Mass.

Profilers
Garvin Mach. Co., New York.
Pratt & Whitney Co., Hartford, Ct.

Pulleys
American Pulley Co., Phila., Pa.
Poole & Son Co., Robt., Baltimore, Md.
Reeves Pulley Co., Columbus, Ind.

Pulleys, Friction Cone
Evans Friction Cone Co., Boston, Mass.

Pulleys, Speed Changing
Speed Changing Pulley Co., Indianapolis, Ind.

Pulley Turning and Boring Machines
Harrington, Son & Co., Edwin, Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.

Pumps, Hydraulic
Elmes Engineering Wks., Chas. F., Chicago, Ill.
Watson-Stillman Co., New York.

Punches, Hydraulic
Watson-Stillman Co., New York.

Punches, Power
Bliss Co., E. W., Brooklyn, N. Y.
Bremer Mach. & Tool Co., Kalamazoo, Mich.
Cleveland Punch & Shear Wks., Cleveland, O.
Hilles & Jones Co., Wilmington, Del.
Long & Allstatter Co., Hamilton, Ohio.
Perkins Mach. Co., Boston, Mass.
Pittsburgh Shear Knife & Mach. Co., Pittsburgh, Pa.

Racks, Cut
Standard Gage Steel Co., Beaver Falls, Pa.

Racks, Tool
New Britain Mach. Co., New Britain, Conn.

Rack Cutting Machines
Fellows Gear Shaper Co., Springfield, Vt.
Gould & Eberhardt, Newark, N. J.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Reed Co., F. E., Worcester, Mass.

Ratchet Drills
Parker Co., Chas., Meriden, Ct.

Reamers
Chadwick & Co., G. B., Portsmouth, N. H.
Cleveland Twist Drill Co., Cleveland, O.
Clough, R. M., Tolland, Conn.
Geometric Drill Co., Westville, Ct.
McCrosky & Huber, Cincinnati, O.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Rogers, John M., Boat, Gage & Drill Wks., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Reaming Stands
Flather & Co., Nashua, N. H.

Recorders, Speed
Starrett Co., L. S., Athol, Mass.

Riveters, Hydraulic
Watson-Stillman Co., New York.

Riveting Machines
Bethlehem Foundry & Mach. Co., So. Bethlehem, Pa.
Chambersburg Engineering Co., Chambersburg, Pa.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Riveters, Pneumatic
Cleveland Pneumatic Tool Co., Cleveland, O.
Standard Pneumatic Tool Co., Aurora, Ill.

Roller and Ball Bearings
Ball Bearing Co., Boston, Mass.
Roller Bearing & Equip. Co., Keene, N. H.

Rolling Mill Machinery
Cleveland Punch & Shear Wks. Co., Cleveland, O.
Diamond Drill & Mch. Co., Birdsboro, Pa.

Safety Valves, Pop
Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

Sawing Machines, Metal, Circular
Cleveland Punch & Shear Works Co., Cleveland, O.
Keystone Mach. Tool Wks., Philadelphia, Pa.
Newton Mach. Tool Works, Philadelphia, Pa.

Schools, Correspondence
Consolidated Schools, N. Y. City.
International Correspon. Schools, Scranton, Pa.

Schools, Technical
Ohio State University, Columbus, Ohio.

Screw Machines, Automatic
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Machine Screw Co., Cleveland, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Screw Plates
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Card Mfg. Co., S. W., Mansfield, Mass.
Hart Mfg. Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Second Hand Machinery
Bowler & Co., Geo. H., Cleveland, Ohio.
Dawson, John H., Chicago, Ill.
Doan & Co., J. B., Chicago, Ill.
Fairbanks Co., Philadelphia, Pa.
Garvin Mch. Co., New York.
Hill, Clarke & Co., Boston, Mass.
Machinery Exchange, Chicago, Ill.
Marshall & Huschart Mchy. Co., Chicago, Ill.
McCabe, J. J., New York.
Pitkin Machy. Co., J. B., Providence, R. I.
Prentiss Tool & Supply Co., New York.
Toomey, Frank, Philadelphia, Pa.
Wormer Machy. Co., C. C., Detroit, Mich.

Separators, Magnetic
Sawyer, Ezra, Worcester, Mass.

Shapers
Amer. Tool Wks., Co., Cincin., O.
Cincinnati Shaper Co., Cincin., O.
Flather Planer Co., Mark, Nashua, N. H.
Garvin Mach. Co., New York.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., Boston, Mass.
Kelly Co., R. A., Xenia, Ohio.
Morton Mfg. Co., Muskegon Heights, Mich.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Perkins Mach. Co., Boston, Mass.
Potter & Johnston Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Ct.
Smith & Mills, Cincinnati, O.
Steptoe & Co., John, Cincinnati, O.

Shears, Power
Bliss Co., E. W., Brooklyn, N. Y.
Bremer Mach. & Tool Co., Kalamazoo, Mich.
Cleveland Punch & Shear Wks., Cleveland, O.
Hilles & Jones Co., Wilmington, Del.
Long & Allstatter Co., Hamilton, Ohio.
Perkins Mach. Co., Boston, Mass.

Shears, Rotary
Bethlehem Foundry & Mach. Co., So. Bethlehem, Pa.
Detrick & Harvey Mach. Co., Baltimore, Md.
Perkins Mch. Co., Boston, Mass.

Shelving, Shop
New Britain Mach. Co., New Britain, Conn.

Slotters
Baker Bros., Toledo, Ohio.
Betts Mach. Co., Wilmington, Del.
Garvin Mach. Co., New York.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.

Slide Rests
Reed Co., F. E., Worcester, Mass.

Springs
Cleveland Wire Spring Co., Cleveland, O.

Sprocket Chains
See Driving Chains.

Stamps, Letters and Figures
Schwerdtle Stamp Co., Bridgeport, Conn.

Stampings, Sheet Steel
Automobile & Cycle Parts Co., Cleveland, O.

Steel, Sheet
Automobile & Cycle Parts Co., Cleveland, O.

Steel, Machinery
Ward & Son, Edgar T., Boston, Mass.

Straightener, Hydraulic
Watson-Stillman Co., N. Y. City.

Straightener, Screw
Towsley Mfg. Co., J. T., Cincinnati, O.

Swaging Machines
Excelsior Needle Co., Torrington, Conn.

Switchboards
C & C Electric Co., New York.
Triumph Elec. Co., Cincinnati, O.

Tapping Machines and Attachments
Baker Bros., Toledo, O.
The Beaman & Smith Co., Providence, R. I.
Bickford Drill & Tool Co., Cin., O.
Cincinnati Mach. Tool Co., Cincinnati, O.
Errington, F. A., N. Y. City.
Fosdick & Holloway Mach. Tool Co., Cincinnati, O.
Garvin Mach. Co., New York.
Geometric Drill Co., Westville, Ct.
Gould & Eberhardt, Newark, N. J.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Taps and Dies
Besly & Co., Chas. H., Chicago, Ill.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Crane Co., Chicago, Ill.
Hart Mfg. Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Threading Dies, Opening
Errington, F. A., New York.
Geometric Drill Co., Westville, Ct.
Jones & Lamson Mch. Co., Springfield, Vt.
Modern Tool Co., Erie, Pa.

Thread Cutting Tools
Hart Mfg. Co., The, Cleveland, O.
Rivett-Dock Co., Boston, Mass.

Tool Holders
Armstrong Bros. Tool Co., Chicago, Ill.
Hill Tool Co., Anderson, Ind.
McCrosky & Huber, Cincinnati, O.

Tools, Diamond
Dickinson, Thos. L., New York.

Tools
See Machinists' Small Tools.

Trimmers, Wood
Amer. Mchry Co., Grand Rapids, Mich.
Leland & Faulconer Mfg. Co., Detroit, Mich.

Transmission Machinery
American Puley Co., Phila., Pa.
Caldwell & Son Co., H. W., Chicago, Ill.
Link-Belt Engineering Co., Philadelphia, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Reeves Pulley Co., Columbus, Ind.

Trolleys and Tramways
Brown Hoisting Machy. Co., N. Y. City.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hunt Co., C. W., West New Brighton, N. Y.
Link Belt Engineering Co., Philadelphia, Pa.
Maris Bros., Philadelphia, Pa.
Pawling & Harnischfeger, Milwaukee, Wis.
Yale & Towne Mfg. Co., New York.

Trucks, Shop
Towsley Mfg. Co., J. T., Cincin., O.

Turret Machines
Barker & Chard M. T. Co., Cin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Mach. Tool Co., Bridgeport, Conn.
Cleveland Mach. Screw Co., Cleveland, O.
Dreses, Mueller & Co., Cincin., O.
Garvin Mach. Co., New York.
Gisholt Mch. Co., Madison, Wis.
Grant Tool Co., Franklin, Pa.
Hill, Clarke & Co., Boston, Mass.
Jones & Lamson Mch. Co., Springfield, Vt.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mach Tool Co., Cincinnati, O.
Pearson Mach. Co., Chicago, Ill.
Potter & Johnston Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Ct.
Warner & Swasey Co., Cleveland, Ohio.
Windsor Mach. Co., Windsor, Vt.

Twist Drills
Cleveland Twist Drill Co., Cleveland, O.
Etna Mfg. Co., New York.
Morse Twist Drill & M. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.

Unions, Brass
Nolte Brass Co., Springfield, Vt.

Valves
See Steam Fittings.

Vises, Wood Workers'
Emmert Mfg. Co., Waynesboro, Pa.
Wyman & Gordon, Worcester, Mass.

Vises, Metal Workers'
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Hollands Mfg. Co., Erie, Pa.
Parker Co., Chas., Meriden, Conn.
Walworth Mfg. Co., Boston, Mass.

Vises, Pipe
Curtis & Curtis Co., Bridgeport, Conn.
Saunders' Sons, D., Yonkers, N. Y.
Walworth Mfg. Co., Boston, Mass.

Vises, Planer and Shaper
Cincinnati Planer Co., Cincin., O.
Hendey Mach. Co., Torrington, Ct.

Welding Machines
Long & Allstatter Co., Hamilton, Ohio.

Wood and Lag Screw Machinery
Baker Bros., Toledo, Ohio.
Cook Co., Asa S., Hartford, Conn.

Wrenches, Drop Forged
Williams & Co., J. H., Brooklyn, N. Y.

Worm Hobbing Machines
Grant Tool Wks., Franklin, Pa.

Worm Gearing
Albro-Clem Elevator Co., Philadelphia, Pa.
Fawcus Mach. Co., Pittsburgh, Pa.
Morse, Williams & Co., Phila., Pa.
Nuttall Co., R. D., Pittsburgh, Pa.

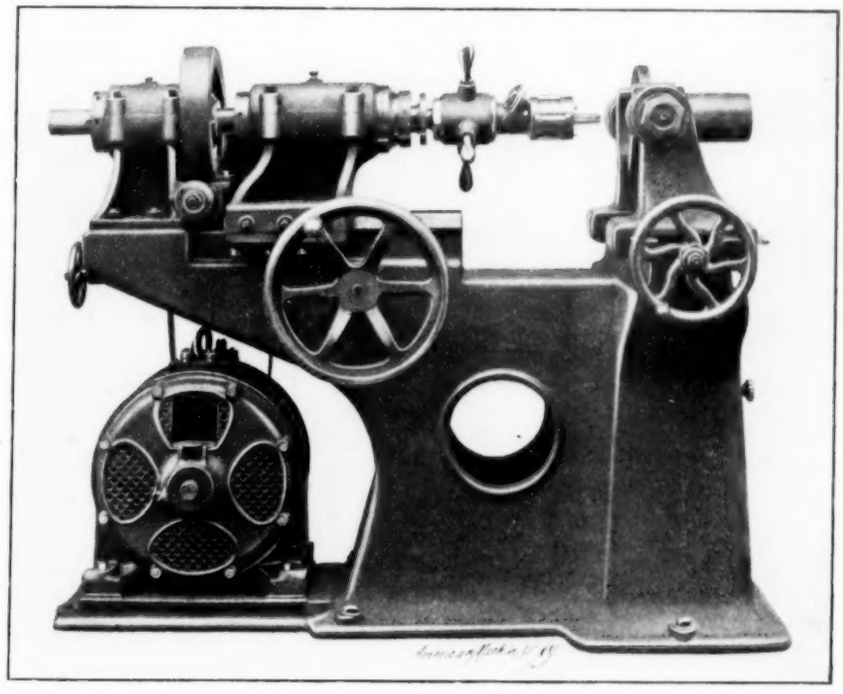
Worm Milling Machines
Cleveland Mach. Screw Co., Cleveland, O.

The Lovekin Expanding and Flanging Machine.

This electrically driven tool makes use of the well-known roller boiler tube expander and beader for the purpose of expanding the ends of pipe into the connecting flanges. It has been designed to economically expand and bead steel and copper pipe from ½ to 8 inches in diameter, and is regularly equipped with a set of fourteen tools taking in this range of sizes. The main spindle is worm driven from the 3 horse-power motor, which is connected with the worm shaft by a belt running on a pair of three-step cones.

The small hand-wheel at the end of the machine over the motor operates a belt-tightener made desirable by the necessarily short center distance between the pulleys.

The machine is designed to do away with the threading of pipes for flanging, and this is found to be especially advantageous in the case of pipes the full strength of which it is desired to retain. Galvanized pipes threaded after being galvanized are not only weakened at the threads, but corrosion sets in there and the life of the pipes is greatly reduced—a difficulty which is entirely overcome by the use of this machine. In some cases on ship board fully 30 per cent. excess weight of piping is carried to secure the necessary strength at the bottom of the threads. Again, for copper and brass tubes, it does away with the necessity for brazing, and tests have shown that the work done by it stands high pressures considerably better than that done by hammering or by brazing. The machine is made by the Keystone Machine Tool Works, Ridge avenue and Hamilton street, Philadelphia.



THE LOVEKIN TUBE EXPANDER.

Friction of Lubricating Oils.

BY R. H. THURSTON.

In an abstract of a paper by Kapff, reproduced from the publications of the British Institution of Civil Engineers, in the "American Machinist" at page 37, the statement is attributed to the writer "that the coefficient of friction of lubricating oils decreases as the temperature rises to a limit of about 82 degrees Cent., from which it is concluded that heating of the bearing to this degree must not be regarded as harmful and that a hot bearing need not be cooled unless its temperature exceeds 100 degrees Cent."

The author of the paper quoted proceeds, very properly, to exhibit the fallacy of a statement that lubricating oils, without qualification, have a minimum limit of friction at 82 degrees Cent. (180 degrees Fahr.) and that it is unnecesary to pay any attention to a hot journal until it attains a temperature of 100 degrees Cent. (212 degrees Fahr.).

As the writer has no record of any paper published on this subject in 1899, has no recollection of having made so broad a statement and entirely agrees with the quoted author in taking exception to it, it would be difficult to say just what was meant in the original, probably misquoted. There are, however, some interesting facts in this connection and it may, perhaps, be further remarked that the work of the writer was mainly pioneer work since supplemented by many investigators. Knowledge in this field is becoming extensive as well as exact. The facts are of great importance, whether derived from early or from late researches.

Lubricating oils are commonly of varied character, from the light spindle oil to the heavy cylinder oil with flashing and burning points far above the temperature of any steam cylinder. Obviously, what is true of the one in this respect may be far from true with the other. Assuming 82 degrees Fahr. to be the temperature intended above, it is also evident that the statement quoted would have very different significance in an engine room at 70 degrees Fahr., in one at 82 degrees Fahr. and in one at 100 degrees Fahr. It is probably true that every such oil has a temperature of best effect; but should it happen that this temperature in a specified case is 82 degrees Fahr., the loss of heat in an engine room of slightly lower temperature would be slight could the bearing be held at 82 degrees Fahr., and would not appear as a sensible quantity in the account.

The fact of a critical limit at this particular temperature (82 degrees Fahr.) I find exhibited only in one of Beachamp Tower's tests of rapeseed oil, a common lubricant in England and on the Continent of Europe.* The figures run thus:

Speed of rubbing 157 to 314 feet per minute; loads 582 to 178 pounds per square inch; coefficients of friction from something over one per cent. at the upper limit of temperature, 90 degrees Fahr., to a minimum at about 82 degrees Fahr. of from 0.78 to 0.87 per cent. and then rising again to from 1 per cent. to a figure 20 to 30 per cent. higher at 75 degrees Fahr.

Many years ago the writer stated: "Both Professor Jenkin and the author have deduced—from the fact that the coefficient of friction of rest is greater than that of motion, while the latter at low speeds steadily and constantly increases as the velocity of rubbing decreases—the conclusion that there is probably a continuous change resulting in the merging of the one into the other," also that "there is a minimum value at some intermediate speed, the precise location of which minimum is determined by the pressure and the temperature." These conclusions have often been since confirmed.

It was also clearly shown that different kinds of lubricating oils exhibit characteristic differences in behavior in this respect.* It was concluded that "these relations of value probably differ, however, with every change of speed and temperature as well as of pressure."†

For example, in a series of values obtained by the writer in the endeavor to ascertain these facts, with a fine steel journal running in bronze at a speed of rubbing of but 30 feet per minute and lubricated with a *real* sperm oil, even then almost impossible to secure in the market, the temperature was varied between 90 and 150 degrees Fahr. while the pressure, 200 pounds, and

* Friction and Lost Work, etc.: N. Y., J. Wiley & Sons, 1885–1898, p. 309.

* Friction and Lost Work, p. 316. † Ibidem, p. 319.

speed were constant; then the temperature was held constant at 110 degrees Fahr. while the pressure was varied and, finally, the last tests were repeated at a constant temperature of 90 degrees Fahr.

In the first set a minimum coefficient of 0.006 was found at 95 degrees; in the second at 100 pounds pressure, the minimum was found to be 0.0025; in the third, the figure marking the critical point was at 100 pounds pressure also, and had precisely the same value as in the preceding tests. "The coefficient of minimum friction is found, usually, nearly constant over a wide range of temperature."*

Studying all the results obtained as above it becomes evident that "every pressure demands a certain degree of viscosity and capillarity to secure, at the same time, thorough lubrication and minimum friction.† With the oil bath and a flooded journal this action is still more marked and "a very great reduction of friction follows moderate increase above common temperatures."‡

Twenty years ago and more, describing some of this pioneer work in a paper read before the American Institute of Mining Engineers, among the deductions announced was this:

(8) The effect of heating journals under conditions here illustrated is to increase friction, above 90 to 100 degrees Fahr., at speeds as low as 30 to 100 feet per minute, while at higher speeds and low pressures the opposite effect is produced," a conclusion carefully limited to "the conditions here illustrated."§

At about the same early date it was shown that, as a matter of business, the economical use of lubricants was secured, not by saving costs in purchasing oils, but by saving power by choosing good oils, and it was further shown that it might readily happen that a saving of a few cents on oils unsuited to the purpose for which they were chosen might result in the loss of many dollars in wasted power which, with a suitable lubricant, would have been saved. "In fact, as is evident, the importance of reduction of the costs of unguents is usually absolutely insignificant in comparison with that of securing the best possible lubrication," and thus of reducing costs of power, of wear and tear and of accidents and stoppages.** It may prove true that it would be better to pay dollars per gallon for a suitable lubricant than accept one of the cheap but unsuitable oils as a gift; although, in its place, the latter might change places in relative value with the former, and there have been cases known in which minimum costs of oils and maximum saving of wastes of power by friction have closely approximated with the same oil.†† This is the ideal case and careful selection of oils to-day when every familiar set of conditions is met by the maker of lubricating oils should enable the buyer to at least attain a fairly close approximation. In any event, it is the cost of wasted power rather than that of good oils that concerns the proprietor of works.

* Friction and Lost Work, p. 321. † Ibidem, p. 322. ‡ Ibidem, p. 327-8.

§ Transactions American Institute Mining Engineers, 1878; Journal of Franklin Institute, 1878; Friction and Lost Work, p. 341.

** Friction and Lost Work, p. 350. †† Ibidem, p. 345.

The Bilgram Automatic Bevel Gear Generating Machine.

About a year ago—at page 110, 1901—we had the satisfaction of presenting to our readers Mr. Bilgram's automatic generating machine for spur and spiral gear teeth, and we have equal satisfaction in presenting herewith his automatic bevel gear machine, which embodies some of the same principles, or, as it might perhaps be more strictly accurate to say, modifications of the methods used for attacking the work in the original hand indexed bevel gear machine have been applied to both the spur and bevel machines, with the result of making them both completely automatic.

Fig. 1, which we reproduce from the article describing the spur and spiral gear machine, will serve to recall the principle of the Bilgram system of generating gear teeth. The tool shown is for a spur or spiral gear, in which, the tooth and space being of uniform thickness, the cutter may act on both sides simultaneously. In cutting bevel gears, because of the tapering shape of the teeth, but one side of the cut-

FIG. 1. THE BILGRAM SYSTEM OF GENERATING GEAR TEETH.

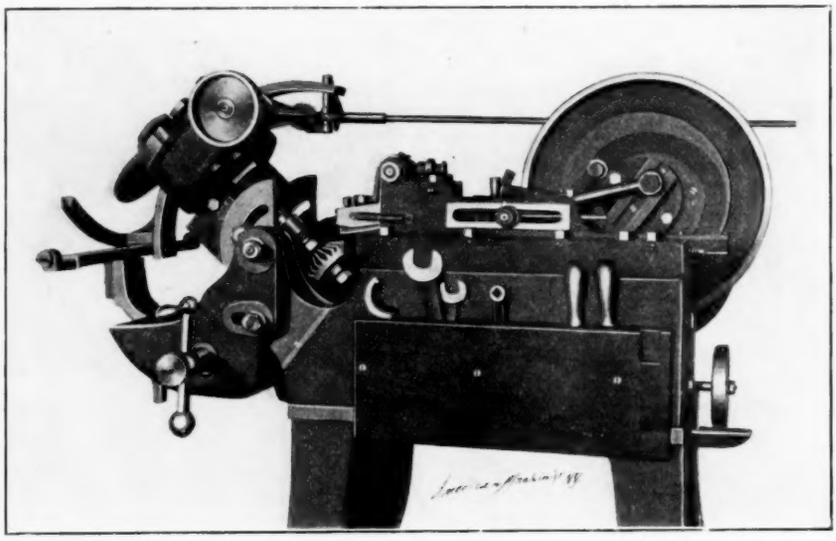


FIG. 2. THE BILGRAM AUTOMATIC BEVEL GEAR CUTTER.

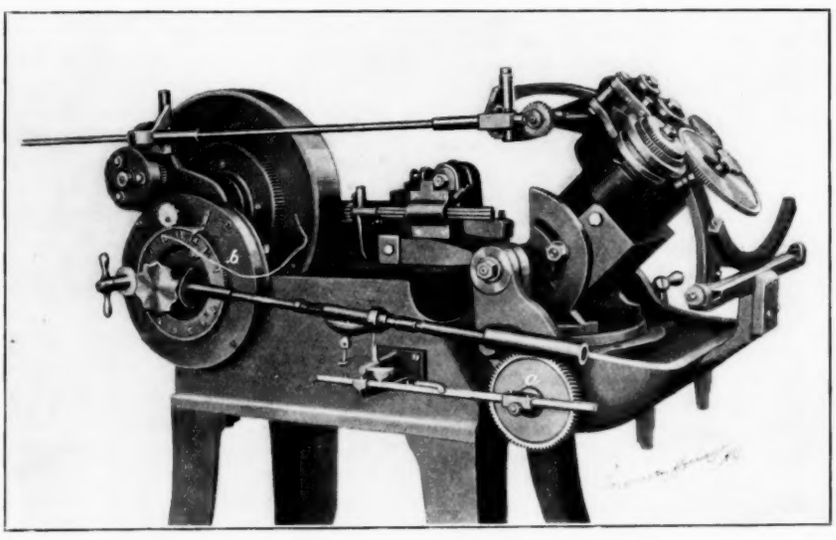


FIG. 3. THE BILGRAM AUTOMATIC BEVEL GEAR CUTTER.

ter can act at a time, but otherwise the action is essentially the same. This figure shows how the tool generates the tooth curve while the tool and blank roll past each other. In the spur and spiral machine the blank simply turns on its axis while the tool traverses past it, as a rack tooth would be driven by the completed stationary gear. In the bevel machine, on the contrary, the tool has no traversing motion, the motion of rotation and translation being both given to the blank—the resultant motion being that of a completed gear rolling on a stationary crown gear—the crown gear in bevel gearing being the analogue of the rack in spur gearing. In addition to these alternative constructions two fundamentally different methods of attack upon the tooth are possible. In the first the tool continues to act on the same tooth throughout the action shown in Fig. 1, which action illustrates the entire generation of a tooth side. After the completion of such a tooth side the machine is stopped, the tool and blank are returned to their initial positions and the blank is indexed, when the machine is started again and the next tooth is made, after which the above described series of operations is repeated. This was the method used in the original bevel gear machine, and it necessitates hand indexing of the blank.

The second method, by which both spur and bevel machines are made automatic, is as follows: After each cutting stroke and during the return stroke, the tool is raised clear of the blank and the blank is turned or indexed to present the next tooth to the tool, each succeeding cut being thus upon a succeeding tooth. Meanwhile the slow traverse of the tool and blank past each other is going on, each indexing or turning movement of the blank being enough in excess of that due to the pitch to accommodate this traversing movement or feed. A single traverse of the tool from left to right, as in Fig. 1, thus serves to cut all the teeth and finish the gear in the case of a spur or spiral gear. A single traverse of the blank from right to left cuts one side of all the teeth in a bevel gear, an opposite hand tool being then inserted to complete the opposite side.

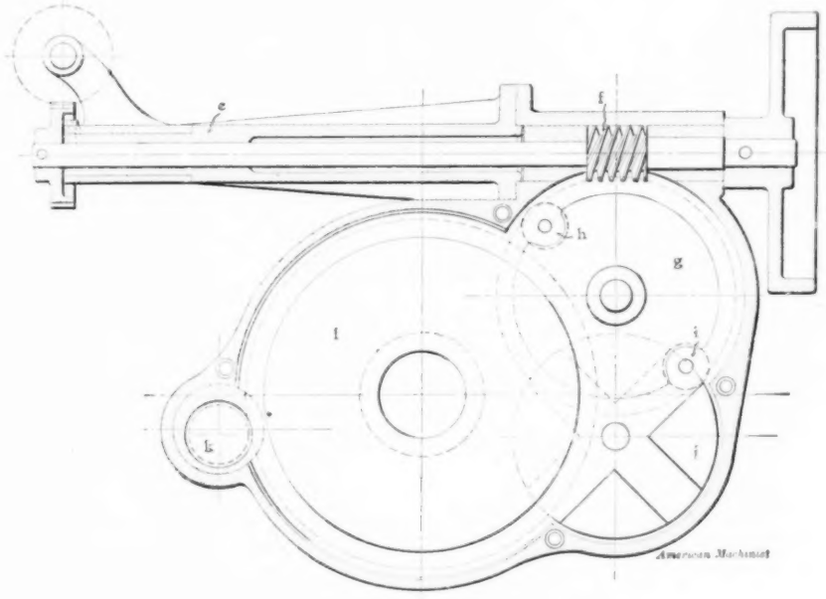


FIG. 4. SECTIONAL ELEVATION OF SPACING HEAD.

Fig. 2 shows the machine from the right-hand side, the position of the work blank and tool being plainly shown. Fig. 3 is from the opposite side and shows the operating mechanism more clearly. To those familiar with Mr. Bilgram's older machines, the fundamental features will be apparent. The entire spacing head is elevated or depressed to determine the cone angle of the gear to be cut. The slow horizontal movement of the blank, represented diagrammatically in Fig. 1, is obtained through a concealed worm on the inner end of a shaft driven by the worm wheel *a*, which in turn is driven by the worm shaft above it, this shaft being driven through a nest of gears within the circular gear box *b*. This movement is, of course, the feed which must be adjustable in rapidity. This adjustment is obtained through the gears inside the gear box *b*, which will be described more fully further on. At *c* is the rolling arc which is a portion of the pitch cone surface of the gear being cut, steel tension bands connecting opposite ends of this arc and its straight track in such manner that a true rolling motion of the arc without slack is obtained. The indexing of the blank is obtained through the shaft *d* and a nest of gears upon and within the spacing head. The connection of this shaft to the spacing head must be flexible in all directions, and this is obtained through a very neat construction of spiral gears, which will be more fully described later. These gears drive a shaft which is carried by a bracket projecting from the spacing head toward the observer in Fig. 3, and also shown at *e*, Fig. 4, which is a sectional elevation of the spacing head. Worm *f* on this shaft drives

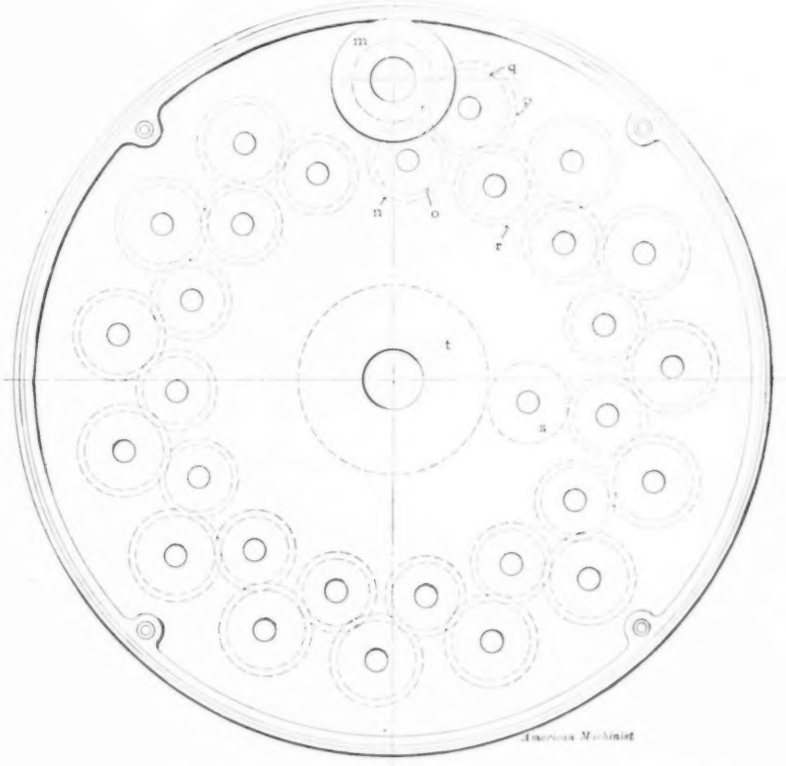


FIG. 5. TRAIN OF GEARS FOR ADJUSTING THE FEED.

worm wheel *g*, the ratio of the gearing being such that worm wheel *g* turns just half as fast as the main driving pulley of the machine. The worm wheel carries two rollers *h* and *i*, which engage the star wheel *j* having two slots at right angles to one another, the action being obviously such that at each engagement the star wheel turns through one-quarter of a turn. Moreover, this engagement lasts during a quarter of a turn of the worm wheel, so that the indexing train is alternately at rest and in motion through equal intervals of time, the timing being such that the train is at rest during the cutting stroke of the tool and in motion during the return stroke. The star wheel is connected to spindle *k* through outside change gears seen in Figs. 2 and 3. Spindle *k* carries a pinion which gears with the master wheel *l* mounted on the work blank arbor. Spindle *k* and its pinion will be seen to be mounted in an eccentric bushing, by which

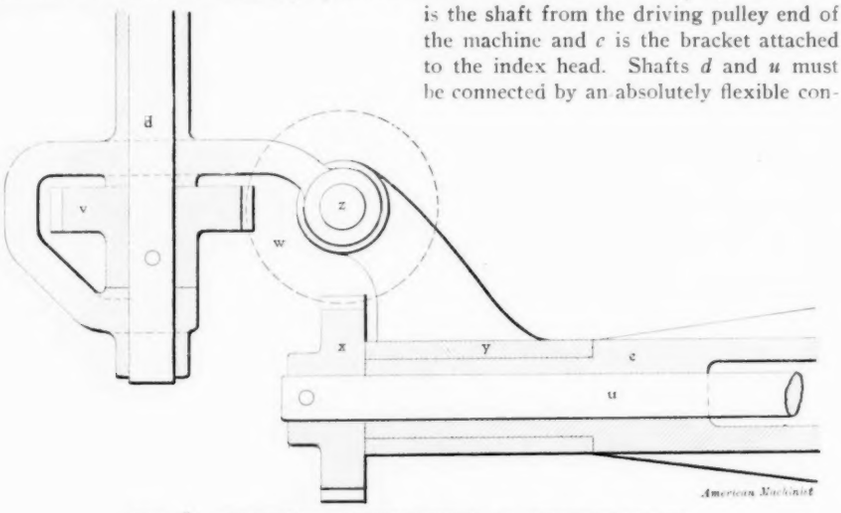


FIG. 6. UNIVERSAL FLEXIBLE JOINT IN INDEXING SHAFT.

they can be adjusted to and from the master gear *l*, and thus—these gears having involute teeth—take up all slack between them. Spindle *k* also carries upon its outer end an anchor index gear, which is not shown very clearly in any of the engravings. A pawl engages the teeth of this gear and positively indexes the work and prevents any displacement due to the side pressure of the cut, and possible lost motion in the change gears, the pawl being raised during the indexing movement. Between work and index there is thus but one pair of gears, and these are adjustable to take up any slack.

The arrangement of feed gears within the gear box *b* of Fig. 3 is shown in Fig. 5. Power enters at *m* and the train of back gears arranged around the circle run at successively slower and slower speeds. These gears, it should be remarked, are arranged in three planes and do not interfere as a single elevation would indicate they might. Gear *m* drives *n*, which revolves with *o*. Gear *o* in turn drives *p*, which revolves with *q*, which in turn drives *r*, the speed of *r* being obviously slower than that of *n* by the ratio of the gearing. The same action is repeated around the circle and an adjustable idler *s* may be set to pick up the speed of any one of the inner gears *n*, *r*, etc., and transmit the motion to *t* from which it goes outside the box and is transmitted to the worm shaft of Fig. 3, the adjustment being by the handles seen outside the gear box in the same illustration. Fifteen speeds are thus obtained from this gear box, the steps being uniform throughout the range—each speed being just three-quarters of the one preceding it. On the shaft with gear *m* is a second gear, not shown, which engages directly with gear *p*. This gear and *m* are both loose upon the shaft, but either may be clamped fast as desired. The feed will move in one or the other direction, according as one or the other gear is clamped.

The flexible connection of the indexing shaft *d*, Fig. 3, to the index train on the index head is shown in Fig. 6, in which *d* is the shaft from the driving pulley end of the machine and *c* is the bracket attached to the index head. Shafts *d* and *u* must be connected by an absolutely flexible connection, and this is accomplished through the three spiral gears *v*, *w*, *x*, which are all equal 45-degree gears. The middle wheel is mounted upon a bracket which is sleeved by a working fit at *y* on the arm *e*. Shaft *d* may thus be raised and lowered freely about shaft *u* as a center. The bearing of shaft *d* is in turn swivel jointed at *z*, the center of gear *w*, and shaft *d* may thus be swung freely to the right or left about the center *z*, and these two motions combined obviously give flexibility in all directions at this end of the shaft. A similar nest of spiral gears will be observed in Fig. 3 at the other end of the shaft *d*, at which end the shaft is engaged with its gear by a feather and groove to permit lengthwise movement. The connection is thus made completely flexible.

Those who profess to dread monopoly of money might well consider present rates of interest as shown by ruling prices of investment bonds. Two to three and a half per cent. net is about the ruling rate of interest. Higher rates mean risk of loss or some form of monopoly.

Experiments on the Flexure of Beams—Discovery of New Laws—VI.

BY ALBERT E. GUY.

THAT SIMPLE PROBLEM.

Stepping now from the laboratory into the study, we find on the table the dear old question patiently awaiting our good pleasure. After a careful dusting let us read it again: *It is required to design a beam having a minimum volume and which, firmly held at one end, must sustain at the other a load* P *acting perpendicularly to the length* L. Although we have accomplished much, much remains to be done, and it behooves us at present to make an inventory of our resources.

Our text books gave us for any bending moment the equation:

$$Px = f\frac{I}{a} \qquad (1)$$

Whence the value of the modulus of resistance is derived in a general way, the terms P, x and f being known, thus:

$$\frac{I}{a} = \frac{Px}{f}$$

This equation is true for any form of section, but absolutely indeterminate for all but plain sections such as the circular and the square; for the rectangular, having $b\,h$ for dimensions, it is necessary to assume a value for one of these in order to obtain the other. Therefore any value of b, for instance, will satisfy the equation, but, as we have previously seen, the area of the section and consequently the area of the beam varying directly as the width, it seems advantageous to make this latter very small. Then our books and our experience warn us not to make the beam too thin for fear of lateral collapse.

We have found the consideration of the deflection of the beam a most valuable auxiliary, because by specifying the degree of rigidity necessary for a given case, we find by equation (7):

$$h = \frac{2}{3} \cdot \frac{1}{m} \cdot \frac{f}{E} \cdot \frac{L}{n}$$

which expresses the hight of the section, irrespective of the shape of the latter. For a rectangular section this value introduced in equation (1) determines b. But, although the dimensions of the section are now known, the stability of the solid is by no means assured, and the latter may collapse before the stress f developed in the beam has attained the value originally assigned to it.

From our experiments was obtained the expression:

$$PL^2 = \frac{\pi^2}{4} E I_1,$$

which asserts positively the limit at which a beam of length L with a section having a moment of inertia I_1—taken with reference to an axis perpendicular to the neutral plane and passing through the center of gravity of the section—will collapse when supporting a bending load P.

Before proceeding further, let it be un-

derstood that this is the absolute limit and that, like the breaking strength of the solid, it must not be reached in practice. Consequently a factor of safety must be selected. During the tests it was observed that the specimen could be vigorously vibrated until the load applied reached ¾ of the limit load, after which care was necessary until ⅞ of the limit was reached, at which point the specimen became very lazy and vibrating had to be checked, because any vibration had a tendency to assume an exaggerated amplitude, although actual collapse took place only with the limit load.

The writer considers a factor of safety of 2 amply sufficient in all cases in which the beam is held and the load is applied in the proper way, as explained before. There will, undoubtedly, be quite a variation of opinion regarding this value. It would be wrong to adopt definitely one factor for all cases, irrespectively of the manner in which the load is applied, and, likewise for f, discernment will have to be exercised.

It is also worthy of remark that when the beam is abruptly vibrated the point of application of the load may be displaced, especially if the load is not rigidly fastened to the beam. In such a case the aspect of the question is changed and the solid becomes subjected to combined stresses, requiring consequently a special treatment differing from that followed here.

Fig. 17 I Beam without Web.

Quite a number of beams so shaped as to be very nearly of uniform strength were tested and found to be weaker than those having a uniform section; but it has not been possible so far to establish a well-defined rule governing the case. By employing formula:

$$PL^2 = \frac{\pi^2}{4} E I$$

modified by a factor of safety of 2 no fear that collapse will occur need be entertained.

Finally, we may say that everything considered it may be found convenient to adopt for the collapse limit the same factor of safety used for the breaking strength of the beam, thereby greatly simplifying the matter.

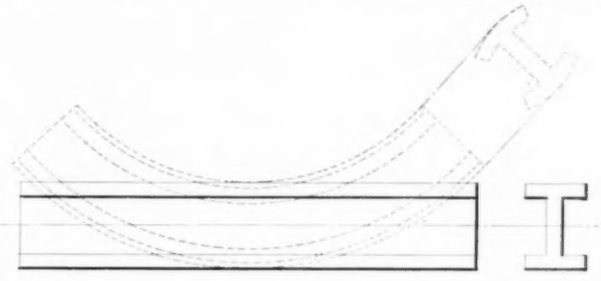


Fig. 18 Action of a Flexible I Beam.

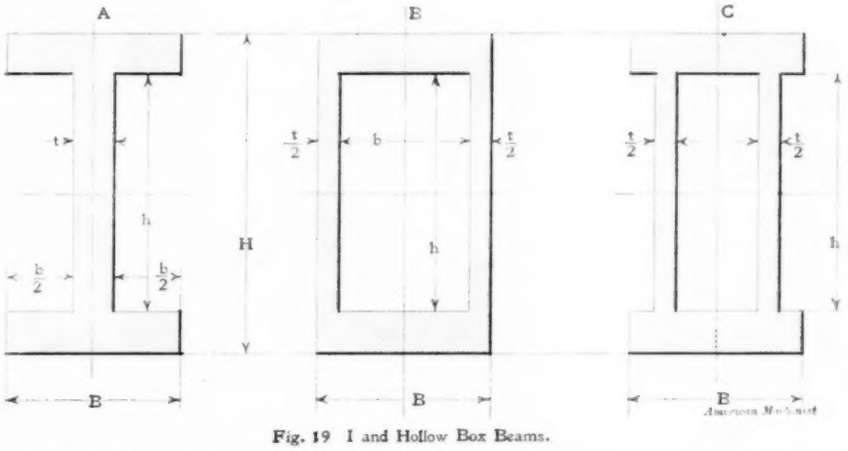


Fig. 19 I and Hollow Box Beams.

THE BEST FORM OF SECTION.

Now, if a rectangular section calculated for strength and rigidity is found to be weak for resisting collapse, it must be altered. By increasing b the required inertia moment I_1 may be attained, but the volume of the beam will be proportionally increased. It is true that the strength will be augmented, but no benefit will be derived from this fact, since the originally adopted value of f insured safety. By modifying the shape of the section the beam can be made to satisfy the three conditions of strength, rigidity and stability, and at the same time its volume may be kept close to the minimum limit.

The most convenient and widely employed is evidently the I-shape. The question is now to determine the proportions of the different parts of the section, or first, what must the area be? As generally treated in practice, the central web is calculated to resist the transverse shearing, although it combines also with the top and bottom flanges to resist flexure. Neglecting for the present this central web, let us assume that the section is composed only of two equal and parallel rectangles, Fig. 17. Its principal moments of inertia are:

$$I = \frac{B}{12}(H^3 - h^3)$$

$$I_1 = \frac{B^3}{12}(H - h).$$

The area $A = B(H - h)$ will be a minimum with $h = H$ when $A = o$; in other words, if we make the thickness of the rectangle infinitely small, B will become infinitely great and, at the limit, the top and bottom parts will be only straight lines of infinite length. It seems therefore advantageous to reduce the thickness. A very simple experiment will show that great care must be exercised in this matter. If a prism of rubber a few inches long and, say, ½x¾ inch is carved longitudinally so that its section be as shown in full lines in Fig. 18, we will have an I-beam very flexible, it is true, but this is a valuable quality for our need. Let us bend it in the form of an arc of circle; it will then be deformed as shown in dotted lines. We see, first, that the top and bottom flanges have not remained parallel in the section; second, that their middle has been kept in place by the rigidity of the central web; third, that their edges, being unsupported, have been brought nearer to the neutral axis, and—as the tensile or compressive stresses are proportional to the distance of the fibers from the neutral axis—they are consequently less strained than the middle portions. Therefrom we conclude that, because of this deformation, the beam has been weakened. The same thing would occur to a beam made of rigid material, like iron, but of course the deformations would not be so pronounced in actual practice. However, for the purpose of testing, if the specimen was bent excessively—at right angle, for instance—the deformation would be similar to that of the rubber prism.

To the writer's knowledge, this very important point has never been treated analytically in such a manner as to establish a practical solution and our authorities generally advise us benevolently "not to make the flanges of the beam too wide and too thin for fear of collapse. Right here is a wide field for investigation, as well mathematical as practical. The problem is indeed very attractive, etc. . . ." Thus left in a lurch, having nothing else to do, if perchance we cast a glance on the illustrated lists of commercial rolled iron and steel beams, such as used on bridge and building construction, we notice that

the sections seem to be made with a view to economy as well as strength; the material seems to be distributed in the most effective manner, and the flanges are tapered, apparently to guard against collapse. Although rather lean, the section looks very strong and rigid. Evidently the proportions have not been chosen at random; on the contrary, they must certainly have been judiciously determined from carefully made experiments. Since these shapes have been sanctioned by general practice, it would be wise to take them for models, or at least to use them as standards of comparision, and especially so in the absence of any other reliable data.

ically between one of the latter and a plain section. However, the writer has worked out a formula expressing very closely the areas of most of the rolled I-beams made in the United States as well as in Europe. It is derived from the comparison—almost unwarranted, but the end justifies the means—of a *hollow square box beam* with a rolled I-beam having the same hight of section, same area A and same moment of inertia I. It is well known, of course, that the moment of inertia of a hollow box section is the same as that of an I section having the same hight, width and thickness of top and bottom flanges, the sum of the thicknesses of the lateral webs being equal to the thickness of the central

obtain very conclusive results. These latter can be shown to better advantage in the form of a diagram, as in Figs. 20 and 21. The abscissæ are simply equal distances for spacing the shapes and have no other meaning, but the ordinates are drawn to scale and indicate the areas of the sections. The top of the ordinates are joined by straight lines. The full lines indicate the areas given in the books of shapes, and the dotted lines those derived from formula (28). It is thus seen that the two series of values are nearly identical.

When such a simple formula—even if found entirely by chance—agrees so closely with good practice, it is advisable, because of the lack of reliable data, to give

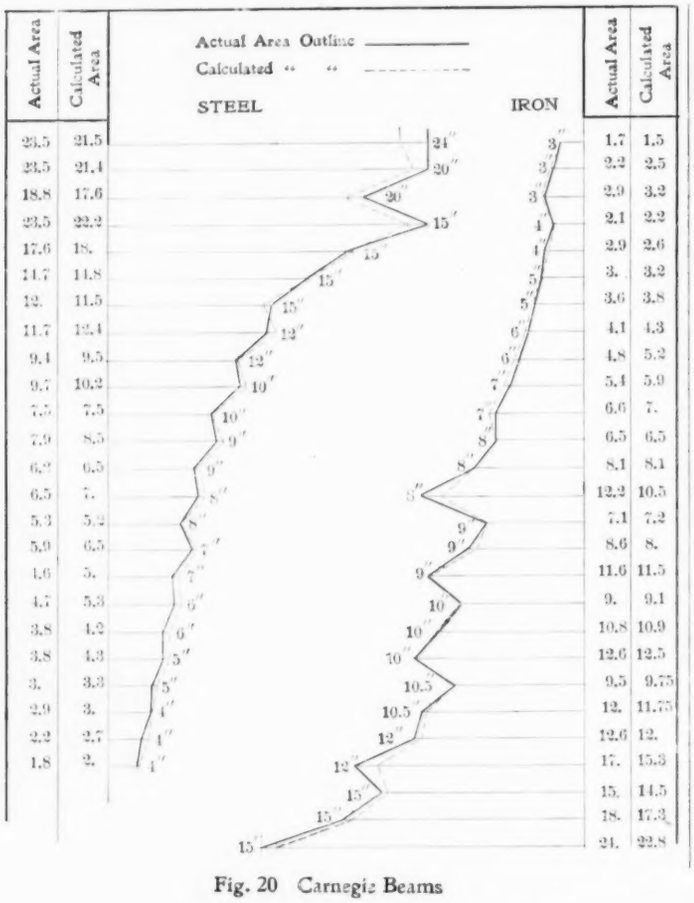


Fig. 20 Carnegie Beams

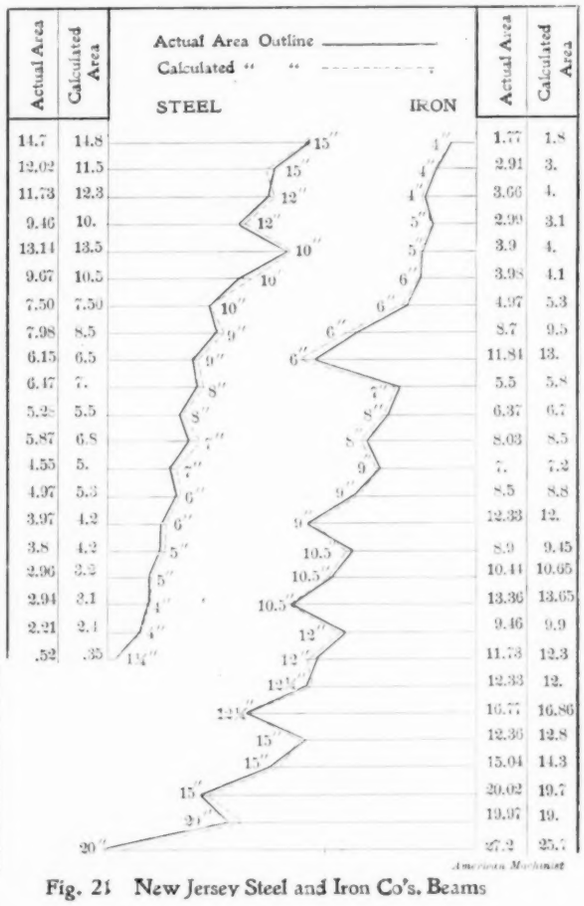


Fig. 21 New Jersey Steel and Iron Co's. Beams

ACTUAL AND CALCULATED AREAS OF I-BEAMS.

The moment of inertia of an I-beam has for its expression:

$$I = \frac{B H^3 - b h^3}{12}$$

We have here one known quantity (H) —determined by the deflection formula— and three unknown: (B), (b), (h). This equation is consequently indeterminate, and values must be assumed for some of these unknown in order to obtain a solution. The same remark applies to the expression for the area of the section:

$$A = B H - b h.$$

These expressions are much more complicated in the case of the commercial rolled beam sections. Hence it does not seem possible to make comparison analyt-

web, as in Fig. 19. Knowing I and H, the question is to find A.

For a hollow square section:

$$I = \frac{H^4 - h_1^4}{12}$$

$$A = H^2 - h_1^2;$$

from these two equations we obtain:

$$h_1^2 = \sqrt{H^4 - 12 I} = H^2 - A.$$

Whence

$$A = H^2 - \sqrt{H^4 - 12 I}. \qquad (28)$$

If we apply this formula to the Carnegie I-beams—steel and iron—the properties of which are given in the well-known pocket-book of shapes, and also to those of the New Jersey Steel and Iron Company, we

it conscientious trial so as to find if it is necessary to modify it before final adoption.

For our case we will consider that equation (28) expresses the minimum (practical) area of the greatest section of the beam.

THE CENTRAL WEB.

Text books do not contain precise formulas by which the web may be calculated; they are unanimous, however, in stating that the thickness must not be too small for fear of collapse. We have solved experimentally the question of the lateral collapse of the beam and have excavated the sectional area from good experience sanctioned by practice. Let us now draw

on our imagination for a reasonable hypothesis of the real function of the web.

To begin with, let us assume that the beam is trussed as shown in Fig. 22. The parts *a*, *b*, *c* are in tension, *d*, *e* in compression. They are respectively the top and bottom flanges of the beam. Coincidently with the stresses developed in them they increase in size as they recede from the point of application of the load; thus the section of *c* is greater than that of *b*, which in turn is greater than that of *a*. The diagonals *g* are in compression and are equally strained. The bars *h* resist equal tensive stresses. These bars and diagonals are to the beam illustrated here what the central web is to a solid beam. The diagonals must be treated as struts and the least moment of inertia of their transverse section must be large enough to insure their safety against buckling. If, out of the total amount of the material composing bars and diagonals, we form a thin plate filling the space between the top and bottom flanges, the result is a solid beam. It would seem at a first glance that no important change has been effected, but with a closer attention we discover that a great complication of stresses has been established in the web. The compressive forces—shown in diagonal lines in Fig. 23—are still there, as are also tensile forces (vertical lines); in addition to these, the top and bottom flanges, being now rigidly fast to the web, transmit to it bending stresses (horizontal lines) proportional to the distance of the fibers from the neutral axis. The determination of the resultant effects of all these stresses at work on a transverse section of the beam—the section being assumed plane before the aplication of the load—belongs to the domain of mathematical analysis of the highest order, on which, for obvious reasons, we will not attempt to trespass.

But although all these stresses combine towards a common effect, their individuality is not obliterated and, for the safety of the structure, each kind of stress must be counteracted. Consequently, since our experiments have taught us that prisms are liable to buckle when under compression produced directly or resulting from bending, and because we may with reasonable certitude believe that the central web of a beam is subjected to similar compressive strains that obtain in the diagonals of a latticed girder, it seems proper to employ, for determining the thickness of the web, the rules governing the collapse of struts.

By adopting 45 degrees for the angle of inclination of the diagonal we are in accord with good practice. Thus we are to treat as a strut a panel of thickness t, length $= \frac{h}{\cos. 45}$, width $= h \times \cos. 45$, loaded axially and parallelly to the diagonal with a weight $= \frac{P}{\cos. 45}$. If we consider that the panel is not guided at the top and bottom

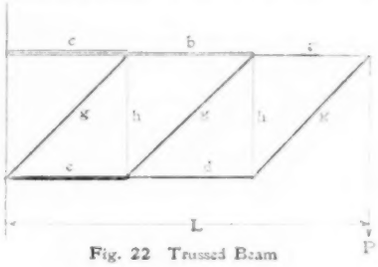


Fig. 22 Trussed Beam

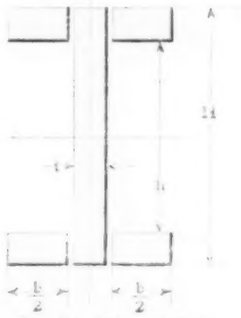


Fig. 24 Elements of an I Beam

—as that is most likely the case—the formula applicable here is:

$$P_0 L^2 = \pi^2 E I_0$$

But for $P_0 L^2$ we must write:

$$\frac{P}{\cos. 45} \cdot \frac{h^2}{\cos.^2 45} = \frac{P h^2}{\cos.^3 45}$$

Using 2 as a factor of safety, we have:

$$\frac{P h^2}{\cos.^3 45} = \frac{\pi^2 E \cdot t^3 h \cos. 45}{2 \times 12}$$

Solving for t, we have:

$$t = \sqrt[3]{\frac{96\, P h}{\pi^2 E}} \qquad (29)$$

Our hypothesis gives us a very simple formula. While it cannot be claimed that the reasoning leading to this result is irrefutable in some parts—leaving aside the free assumption of the inclination angle of the diagonal—where it is primarily at fault is in dealing too summarily with such an important subject.

THE WIDTH OF THE SECTION.

If we decompose the transverse section of an I-beam into several elements, as shown in Fig. 24, we do not change its moments of inertia, for we have:

$$I = \frac{B H^3 - b h^3}{12} = \frac{t H^3 + 2\left(\frac{b}{2}\right)(H^3 - h^3)}{12}$$

in other words, the total moment of inertia is equal to the sum of the moments of inertia of the parts, taken with respect to the same neutral axis.

The unknown quantity in this case is B. The area of this section is $A = t h + 2\left(\frac{b}{2}\right)(H - h)$.

Calling I_2 the moment of inertia of the flanges alone and A_2 their area, we have:

$$I_2 = \frac{12\, I - t H^3}{12} = \frac{b (H^3 - h^3)}{12};$$

$$A_2 = A - t h = b (H - h); \qquad (30)$$

whence, by combining:

$$\frac{12\, I_2}{A_2} = \frac{H^3 - h^3}{H - h}$$

Solving for h, we have:

$$h = -\frac{H}{2} + \sqrt{\frac{12\, I_2}{A_2} - \frac{3 H^2}{4}}$$

$$= -\frac{H}{2} + \sqrt{\frac{12\, I - t H^3}{A - t H} - \frac{3 H^2}{4}} \qquad (31)$$

This value introduced into equation (30) gives us b, and as $b + t = B$ the section is entirely determined as far as strength and rigidity are concerned. It remains to calculate the moment of inertia I_1 and

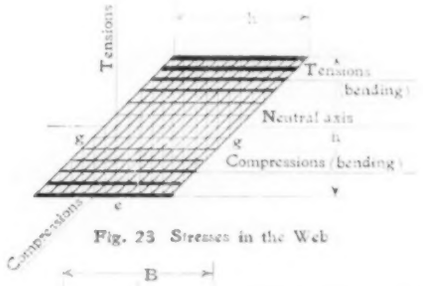


Fig. 23 Stresses in the Web

Fig. 25 A Practical Example

compare it with that required to insure safety against lateral collapse. If this value is superior or equal to the required one, the problem is solved; if it is only slightly inferior to it, the flanges may be widened a little but kept of the same thickness, the increase of area resulting therefrom being negligible; if it is greatly inferior, two ways may be used to remedy the trouble: (I) Calculate the flanges anew for the required inertia moment; (II) Divide the central web in two parts and make the section as shown in Fig. 19 shapes *B* or *C*.

EXAMPLE.

To illustrate the use of the formulas established, let us undertake to solve the following problem:

To determine the maximum transverse section of a beam of uniform strength held horizontally at one end and loaded ver-

tically at the other. The weight of the beam is not to be taken into consideration and the following data are furnished:

Length of beam = 100 inches = L,

Load applied = 40,000 = P,

Modulus of elasticity = 28,000,000 = E,

Allowable fiber stress = 15,000 pounds per square inch = f,

Allowable deflection = $\frac{L}{400} = \frac{L}{n}$.

Deflection coefficient depending on shape of beam = $\frac{2}{3} = m$.

SOLUTION.

Hight of section = H.

By formula (7)

$$H = \frac{2}{3} \cdot \frac{1}{m} \cdot \frac{f}{E} \cdot \frac{L}{n}$$

Hence $H = \frac{2}{3} \cdot \frac{3}{2} \cdot \frac{15{,}000}{28{,}000{,}000} \cdot 100 \times 400 = 21.428''$; say $H = 21\frac{1}{2}''$.

Bending moment, $PL = f\frac{I}{a}$ $a = \frac{H}{2}$

Moment of inertia, $I = \frac{HPL}{2f}$

Hence

$$I = \frac{21.5 \times 40{,}000 \times 100}{25 \times 15{,}000} = 2{,}866.66.$$

Moment of resistance,

$$\frac{I}{a} = \frac{2I}{H} = \frac{2 \times 2{,}866.66}{21.5} = 266.66$$

If the section is made rectangular

$$\frac{I}{a} = \frac{BH^2}{6}$$

Whence $B = \frac{6I}{aH^2} = 3.4613''$.

Area of section . . . $A = BH = 3.4613 \times 21.5 = 74.418$ square inches.

In the case of an I section the area, as per formula (28), would be

$$A = H^2 - \sqrt{H^4 - 12I}$$

Hence

$$A = (21.5)^2 - \sqrt{(21.5)^4 - 12 \times 2{,}866.66} = 38.85 \text{ square inches.}$$

By comparing these two values we see how advantageous the I section is, its area being about one-half that of the rectangular section. If we adopt the former, it remains to determine the thickness of the web and the sizes of the flanges, for the hight of section is the same in both cases.

Thickness of the web, as per formula (29),

$$t = \sqrt[3]{\frac{96PH}{\pi^2 E}} = \sqrt[3]{\frac{96 \times 40{,}000 \times 21.5}{\pi^2 \times 28{,}000{,}000}}$$

$$t = 0.6685''.$$

The distance h between flanges, Fig. 25, is given by equation (31):

$$h = -\frac{H}{2} + \sqrt{\frac{12I - tH^3}{A - tH} - \frac{3H^2}{4}}$$

Hence

$$h = -\frac{21.5}{2} + \sqrt{\frac{(12 \times 2{,}866.66) - (0.6685 \times 21.5^3)}{38.85 - (0.6685 \times 21.5)} - \frac{3 \times 21.5^2}{4}}$$

$$h = 17.31''.$$

From equation (30) we obtain:

$$b = \frac{A - th}{H - h} = \frac{38.85 - (.6685 \times 17.31)}{21.5 - 17.31} = 5.818''$$

And finally . . . $B = b + t = 5.818 + 0.6685 = 6.51''$.

The section is now completely determined (see Fig. 25) and the problem is solved. However, the sizes obtained through the formulas—such as the thickness of the web, for instance—may have to be modified to facilitate the process of manufacture. Fillets may be provided at the junctions of the web and the flanges; the angles may be rounded, etc.; but we have found in a simple manner, and without hesitation, the safe and economical limits which are of all importance in this case.

If anyone, thoughtlessly, were to make the section rectangular and of the same area as that found for the I shape, he would have cause for regret, as we will presently see.

By introducing the value of $A = BH$ into the equation of the bending moment $PL = f\frac{BH^2}{6}$, we have $PL = Af\frac{H}{6}$, whence

$$H = \frac{6PL}{Af} = \frac{6 \times 40{,}000 \times 100}{38.85 \times 15{,}000} = 41.185''$$

$$B = \frac{A}{H} = \frac{38.85}{41.185} = 0.943.$$

The moment of inertia I_1 taken with respect to the vertical axis of the section is:

$$I_1 = \frac{B^3 H}{12} = \frac{(0.943)^3 \times 41.185}{12} = 2.881.$$

The moment of inertia I_1' required to insure safety against lateral collapse may be derived from equation:

$$PL^2 \frac{\pi^2}{4} E I_1'.$$

Employing a factor of safety of 2, we have:

$$I_1' = \frac{8PL^2}{\pi^2 E} = \frac{8 \times 40{,}000 \times 100 \times 100}{\pi^2 \times 28{,}000{,}000} = 10.58$$

Comparing the values of I_1' and I_1 we see that the latter is nearly four times too small and that the beam, if made with such a rectangular section, would immediately collapse when the load is applied.

But as originally designed, with a hight $H = 21.5''$ and base $B = 3.46''$, the moment of inertia I_1 would be:

$$I_1 = \frac{(3.46)^3 \times 21.5}{12} = 74.29,$$

and the beam would have ample strength to resist lateral collapse.

As for the I section, its moment of inertia I_1 is:

$$I_1 = \frac{(B^3 - t^3)(H - h) + Ht^3}{12}$$

Hence

$$I_1 = \frac{(6.51^3 - .6685^3)(21.5 - 17.31) + (21.5 \times .6685^3)}{12}$$

$$I_1 = 95.706.$$

This value insures perfect security against lateral collapse.

(Concluded next week.)

Fine File Making.

Not long since an "American Machinist" representative had the privilege of going through a file factory in which many interesting things were seen. This factory is located in Elizabeth, N. J., and belongs to the American Swiss File & Tool Company, whose office is at 23 John street, New York. The name American Swiss seems to have been given this company in recognition and acknowledgment of the splendid qualities of such Swiss files as the Grobet, as well as to indicate the character of the files made here; the object being to make them at least as good and, where possible better.

Mr. E. P. Reichhelm, who is at the head of the business, states that he found it impossible to get on with a file maker as superintendent of the works. The files to be made differ so much in character from the ordinary article that the methods of making them must also differ quite radically, and the man who is in charge is one who got his training rather as a user of fine files than as a maker of them, and whose work for years had been the design and construction of special machinery for performing various operations in manufacturing—a man withal entirely devoid of the file maker's devotion to traditional methods.

For, contrary to what is perhaps the general impression, such files are not cut by hand, but by machines; the round ones by a rolling operation that may be likened to knurling perhaps more than anything else, and the others by machines with rapidly striking chisels. Some of the machines for this work had to be imported but nearly all of them have been greatly improved in the direction of refining them for the high-grade work they must do in manufacturing a line of files which is the duplicate of the Grobet list, so far as sizes, shapes and cuts are concerned.

As would be expected, the gas furnace is extensively used in this work, and to its use principally Mr. Reichhelm attributes the uniformity and the superior durability for which his files are acquiring a reputation. The forgers who sit at trip or drop hammers, for instance, have each a small gas furnace, which, when once adjusted for heating certain blanks, is absolutely certain to give every one precisely the same heat, and usually the adjustment of air and gas valves is such as to cause a slight deficiency of oxygen in the flame, as indicated by a slight redness, which does away almost entirely with all tendency to scale forming; the freedom from scale about the hammers being very noticeable. Then in annealing, hardening and all subsequent operations of heating the gas furnace insures absolutely uniform treatment for a given lot of steel or blanks, this treatment being the more carefully adjusted and looked after because it has to be done only once for a given lot of blanks, or set of conditions, and when the proper furnace

temperature and rate of heating are secured they remain constant until purposely altered. To this uniformity of conditions the fact that the gas used is made by one of the American Gas Furnace Company's machines also contributes its share.

Charpy's Methods of Testing Metals.

Among the various methods proposed for supplying deficiency in the information afforded by tensile tests, tests on nicked or notched bars now appear to find the most favor, as they bring out the good or bad qualities of which the usual tests give no indication, while completing to advantage the information afforded by them. In some tests carried out by M. Charpy, chief engineer at the Saint Jacques Ironworks, Montlucon, and the results of which he communicated to the Société des Ingénieurs Civils de France, three series of bars, all identical as regards their chemical composition, were taken from one and the same portion of a steel ingot, and each was subjected to special thermic treatment, followed by the ordinary tension, compression and impact tests, which afforded quite different results from those yielded by similar but nicked bars. While the utility of carrying out tests with nicked bars is no longer called in question, the only difficulty—that connected with a definition of the nick—which might occur in practice may, observes M. A. Dutreux in the "Genie Civil," be entirely got over by adopting a nick of rounded form, the other circumstances of the test, especially the dimensions of the bars themselves, being of less importance. M. A. Pourcel, however, remarks in the same publication that M. Charpy's method, although constituting a valuable contribution towards solution of the problem, does not appear to satisfy the conditions formulated by the International Association as to the methods of testing materials for determining the homogeneity of iron and steel with the object of eventually employing such method for the reception of these metals.—"The Engineer."

Galvanic Coloring of Metal.

In an abstract by "Lightning" of an article in "L'Electrochemie" on the coloration and protection of metals, a large number of receipts are given. Gilding on steel is imitated by galvanically coating with copper from a cyanide bath, then with a thin film of zinc. After drying and polishing, the article is heated in linseed oil to 160 degrees Centigrade, when it is stated that the surface becomes of a red-brass color, as if there had been a real alloying of the copper and the zinc. Iron can be protected from rust by a layer of molybdenum, deposited from a bath containing 1 gramme of ammonium molybdate and 15 to 20 grammes of ammonium nitrate per liter, with a current of 2 to 5 amperes per square decimeter. All varieties of iron can be covered with an adherent and unalterable deposit of peroxide of manganese by making them anodes in a bath containing about 0.05 per cent. of manganous chloride or sulphate with 5 to 25 per cent. of ammonium nitrate, the bath being cold, the cathodes of carbon, using a weak current of 1 to 2 amperes. Selenite of copper is recommended for coloring iron and steel brilliant black or blue-black, according to the strength; the layer, after firing, is very permanent. The bath is made with selenious acid 6 to 10, copper sulphate 10, nitric acid 4 to 6, to the liter of water. It can be also used for copper and brass with feeble currents. Mathey colors watch-hands and other small metal articles with gold or platinum, but not with silver, by placing them on an anode plate under about 3 cm. of solution, and dipping the cathode into the liquid over them until the required tint is produced.

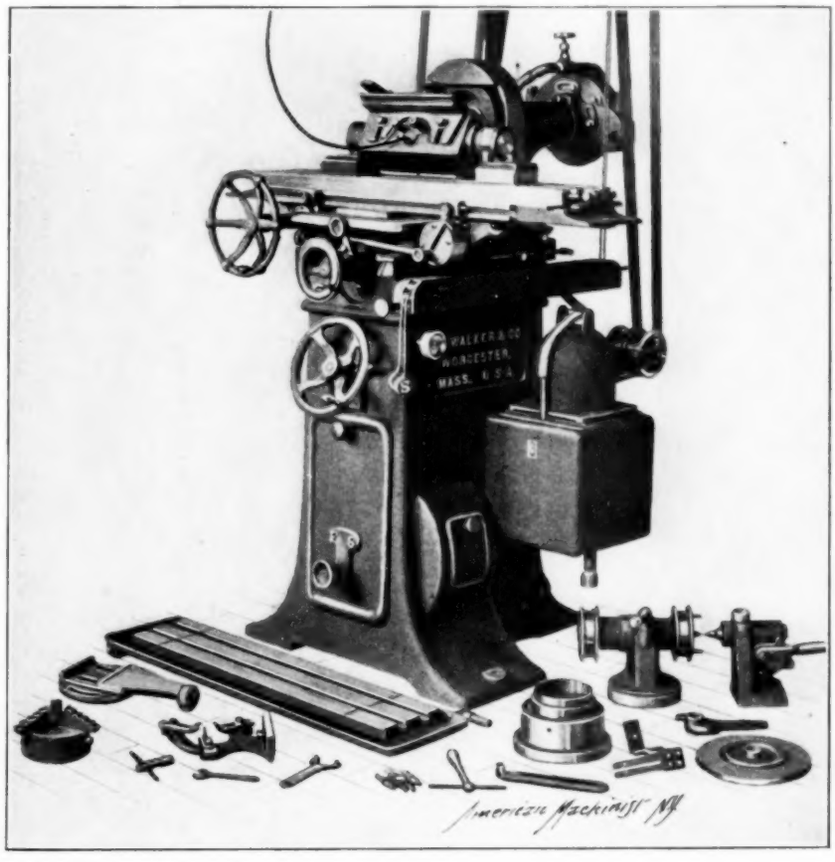


FIG. 1. THE WALKER AUTOMATIC UNIVERSAL SURFACE GRINDER.

The Walker Automatic Universal Surface Grinder.

Our illustrations show some features of a new grinder produced by the O. S. Walker Company, of Worcester, Mass. Fig. 1 shows the complete machine together with all the attachments that may accompany the machine if desired.

The machine is driven by a two-speed countershaft which is started at either speed by pulling one of the weighted cords marked *S*, Fig. 1, and stopped by pushing the adjacent knob. An adjustable stop operates in connection with this mechanism so that the machine stops automatically when the cut for which it is set is finished.

The platen has an automatic movement of 22 inches and will reverse on a stroke of ¼ inch. There are two speeds of travel of the platen, one being double the other and the change can be made while the machine is running. The automatic cross-feed moves the carriage at both ends of the stroke and operates the stop at any point whether feeding toward or away from the wheel stand.

The grinding spindle head presents some new features both in the belting arrangement and the construction of the bronze boxes. Fig. 2 shows a section of the head showing the path of the belt. The belt runs in the direction indicated by the arrow, the down-running part coming in on the center line of the column about which the head swivels. On this account the swiveling of the head does not affect the running of the belt on the machine pulleys, and the countershaft pulley is made wide enough to allow for the slight running of the belt at that end. Inside the head the belt passes over an idler *K*, then around the spindle pulley, giving a contact angle of about 200 degrees, and finally around an idler *L* and then to the countershaft pulley. Idler *L* swivels about

the upper end of the elevating screw, but other than this its position is fixed; so that when the head is adjusted vertically the movement of *K* and the spindle pulley does not alter the length of the belt. This arrangement not only gives uniform belt tension for all positions of the grinding head, but also allows the head to be turned through 90 degrees either way from the position wherein the spindle is parallel to the countershaft. The latter makes it possible to use a wheel on either end of the spindle without in any way interfering with the driving belt.

The spindle boxes project unequally from the head so as to support the spindle well over the work for flat surface grinding by using the wheel on the long overhanging end. The space required for face grinding is obtained by putting the wheel on the short end of the spindle.

The bronze boxes in which the spindle runs are made adjustable for wear, as indicated in the section Fig. 3. *G* is the hub of the head casting containing the boxes, *B* the box and *A* the spindle. *F* is a key screw with flattened point which fits a slot milled the whole length of *B*. This slot is milled deep so as to leave quite a thin wall between the bottom of the slot and the spindle, this wall serving as a spring hinge about which the halves of the box turn when the adjustment is being made. The opposite side of the box is milled open with a beveled edge slot, in which a packing strip *D* is held by a screw *E*. The screw *C* bears on a step milled in the bronze and serves to tighten the top of the box against the strip *D*. The point of *E* is slightly rounded so that it simply holds *D* in place and allows the pressure of *C* tending to rotate the whole box to be resisted by *F*.

The accessories include forms of this company's well-known magnetic chucks, and a head and footstock for cylindrical grinding.

Fig. 4 shows a machine of similar design but entirely motor driven, making it thoroughly portable. It is mounted on wheels so that it may be readily moved from place to place in the shop. This machine has two 110-volt continuous current motors, one direct connected to the grinding spindle and the other within the base for operating the feeds.

In the machine which we illustrate the magnetic chuck is made an integral part of the platen and the electrical connections are such that putting on the current to start the machine energizes the magnet for holding the work.

An automatic switch and starting box is

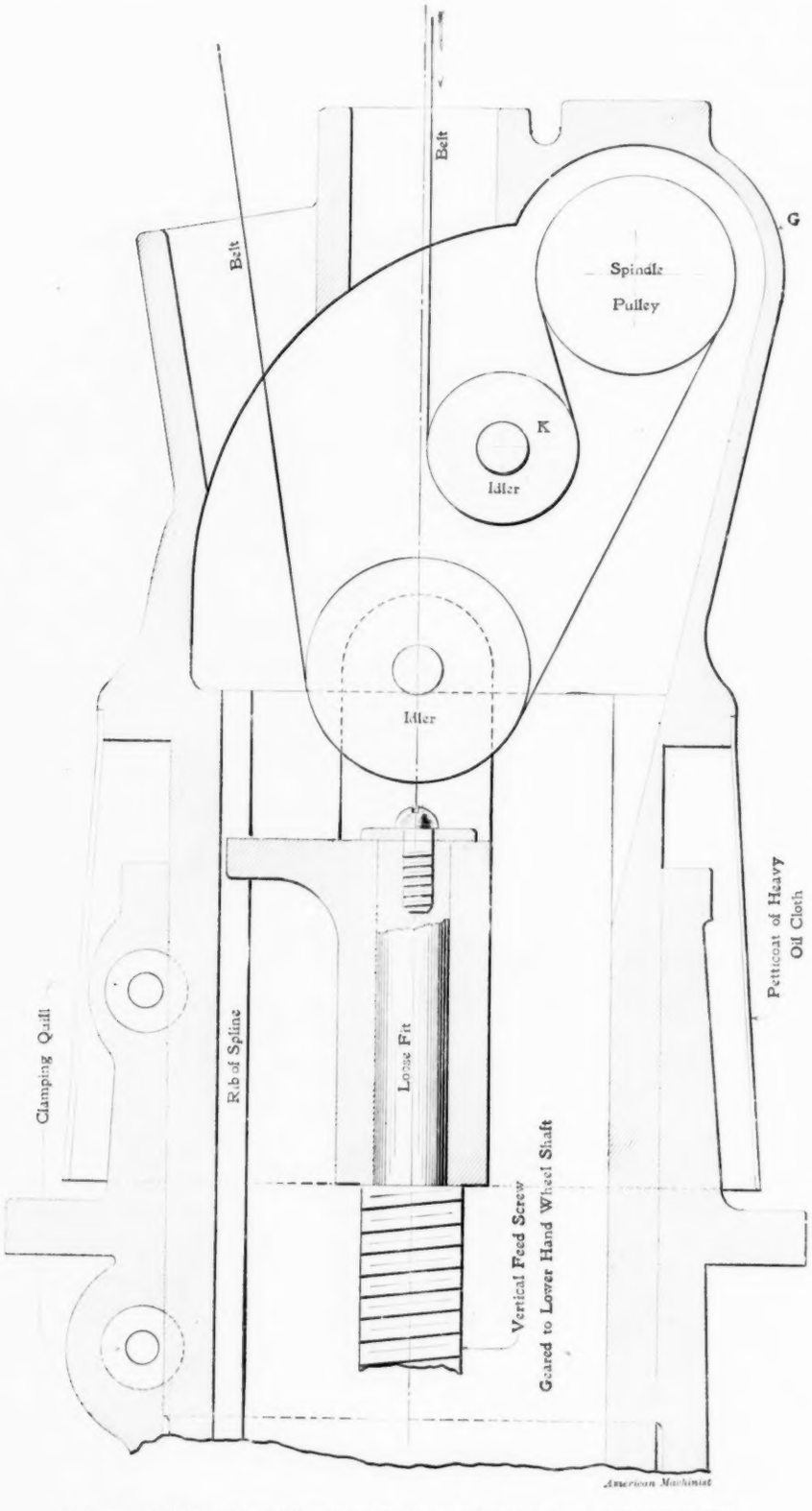


FIG. 2. VERTICAL SECTION THROUGH HEAD SHOWING BELT ARRANGEMENT.

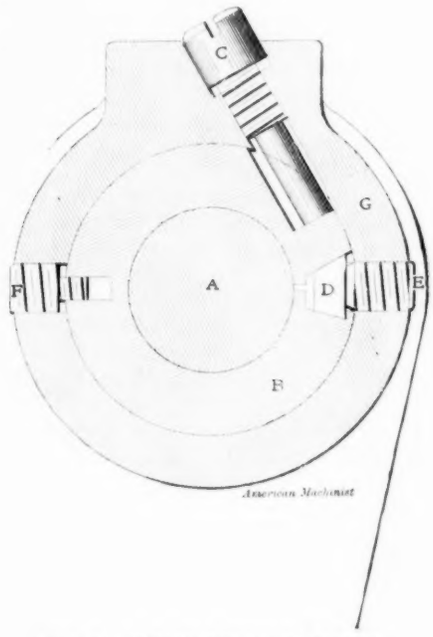


FIG. 3. SECTION THROUGH SPINDLE.

provided which stops the machine when the cut is completed and, if desired, rings a bell to call attention to the fact. The same appliance entirely disconnects the motors in case the operating current fails, avoiding danger to the windings from the sudden rush of current when the supply is renewed.

A Decimal System for Numbering Working Drawings.

BY A. D. WILLIAMS.

Mr. Henry L. Hutson gives at page 1427, 1901, an illustration of the application of the decimal classification to drawings for pumping machinery, and in an editorial the system is spoken of as having been worked up to suit the requirements of a locomotive works and as having been used by some bicycle works. It is also being used in the office of the Chicago & Western Indiana Railroad, where it was introduced in 1898, the system being described in "Engineering News" for September 5, 1901.

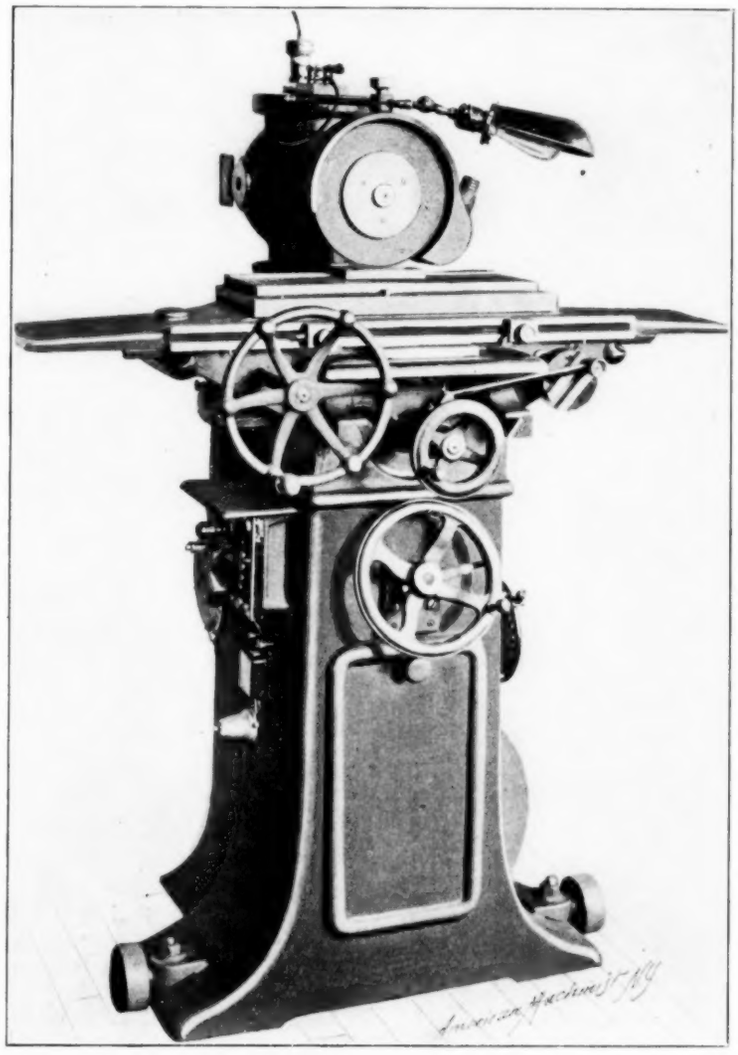


FIG. 4. THE WALKER GRINDER, MOTOR DRIVEN.

The writer tried some time ago to get this system into use in the engineering office of a steel plant, but it got no further than a rough sketch. Later, however, he worked out the system completely, and while not thoroughly perfected it seems to cover the field better than other methods.

The principle of the decimal system is very simple, and, as there is no practical limit to the number of subdivisions, it can be expanded indefinitely. The Dewey Decimal System, used in libraries, is arranged to cover a very wide field, and it would be possible to cover the entire scope of engineering requirements by similar methods. It is hardly likely, however, that any such general scheme will be adopted, though it might be praticable to do so by the aid of the various engineering societies.

There are a great many different systems used in indexing drawings, most of which have some good points, but very few are sufficiently elastic to cover a wide field.

Most of these systems are gotten up in a hurry, when the growth of the business has made something an absolute necessity, and this usually results in no thought being given to anything beyond what is absolutely essential. Time goes on and new lines being taken up, the result is usually a very clumsy system which leads to lots of confusion. There is no way to introduce the needed sub-classes, and the system gradually falls into contempt. To change the system in any large office is expensive and the cost of the change shows on the books, while the time that it saves cannot be shown directly, but the increased efficiency of the office will show in time.

No system, however good, can run itself, and the common practice of putting a boy on the index will spoil it as quick as anything. The card writer must be something better than a machine; copious cross references are needed. Often, to thoroughly index the subject matter of a drawing will take a number of cards, as it is often advantageous to index individual pieces. Naturally the pattern records are another place where trouble can be found without looking very hard. In most places patterns are altered from time to time, and then it is next to impossible to tell what is what without hunting up the pattern itself, so that the attempt to utilize an old pattern may be, and often is, more expensive than a new one. Sometimes a search of this kind ends without finding a trace of the pattern.

Keeping an accurate track of machines built is another place where fall-downs are liable to cause trouble. Imperfect records on one hand and the omission of shop marks on the other assist, as does the fact that a number of different names are used for similar pieces.

Following are the salient outline features of the system as adapted to the needs of a steel plant:

The main division numbers, 000, 100, 200, 300, etc., are used respectively for all plans and general sheets referring to the division concerned. 100 includes general plans covering more than one department, and all small-scale plans with cross references to departments covered.

The class or tens divisions contain general drawings of the subdivisions, the subclasses or units divisions being limited to details only. Further subdivisions would probably be necessary in some cases.

A card index with cross references and written by someone who knew what to do would be an essential part of the system. The main division numbers or whole hundreds are apportioned as follows:

000 Office and Reference Sheets.
100 General Plans, Yard, Buildings, Tracks, Proposed Work.
200 Blast Furnace Department.
300 Bessemer Department.
400 O. H. Department. Heating and Other Furnaces.
500
600 Mills.
700 Power Plant, Engines, Boilers, Pumps, Piping.
800 General Machinery.
900 Mines, Docks.

Taking up the 000 main division, it is

subdivided thus, there being in this case but little need of subdivision and most of the class numbers or tens divisions being not used:

000 General Sheets.
010 Office Standards.
20
30
40
50
60
70
80
90

Class 010 is further subdivided thus:

010 General Standards.
1 Dated Sheets.
2 Structural Standards.
3 Mechanical Standards.
(Remaining units or sub-classes not apportioned.)

The 100 main division is subdivided thus:

100 General Drawings.
10 Buildings.
20 Sewers.
30 Broad Gage Tracks.
40 Narrow Gage Tracks.
(Remaining tens divisions or classes not apportioned.)

The class 110 is subdivided thus:

110 Buildings, General.
1 Foundations.
2 Structural Details.
3 Crane Runways.

Again main subdivision 200 is subdivided as follows:

200 General Drawings and Plans.
10 Blast Furnaces.
20 Stoves and Gas Stoves.
30 Hot and Cold Blast Mains.
40 Ore Handling and Stock.
50 Hot Metal and Cinder Handling.

As before Class 210 is subdivided, the divisions being as follows:

210
1 Foundations.
2 Cast Details.
3 Structural Details.
4 Lining.
5 Top Charging.
6 Cooling and Piping.

Further examples of the subdividing of the tens classes are the following:

220
1 Foundations.
2 Cast Details.
3 Structural Details.
4 Lining.
5 Gas Pieces.

230
1 Cold Blast Mains.
2 Cold Blast Valves.
3
4
5 Hot Blast Mains.
6 Hot Blast Valves.

240
1 Storage Bins, etc.
2 Cars and Lorries.

250
1 Foundations.
2 Pig Machine and Conveyor.
3 Mixer.
4 Ladles, Cars, etc.

The illustrations could be multiplied indefinitely, but further examples can scarcely make the subject plainer.

Improved Speed Changing Pulley.

Some time ago we published an account of a speed-changing pulley which was self-contained and adapted especially to use in driving an engine governor. Since that time the makers, the Speed Changing Pulley Company, of Indianapolis, Ind., have further developed the idea and have applied it to machine-tool countershafts and in some cases to the main spindles or feed shafts of machine tools in a way that is interesting and which seems to constitute one more step in the movement toward the realization of the modern dictum, "the stepped pulley must go."

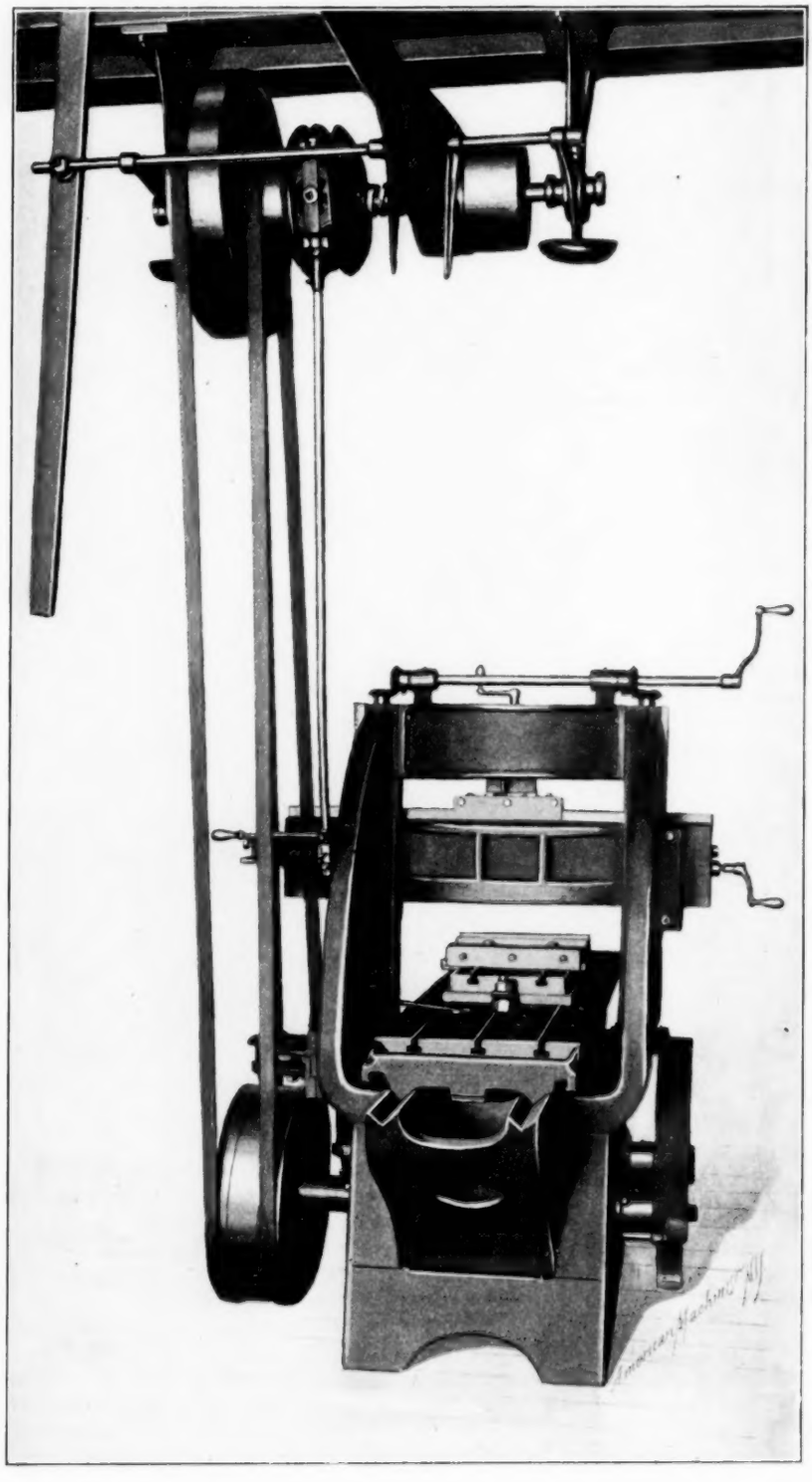


FIG. 1. SPEED CHANGING PULLEY APPLIED TO A PLANER COUNTERSHAFT.

Our half-tone shows the pulley applied to a planer countershaft in such a way as to enable the platen of the machine to be run back at a constant maximum speed while the cutting speed can be changed to suit the material or character of the work without stopping. The use of three friction wheels has proven very much more satisfactory than two, as formerly used. Not only is it possible to get stronger driving power, but the loose wheel being supported or pushed upon at three points instead of at two diametrically opposite points, it runs better and gives better satisfaction generally. The arrangement of three wheels is shown by Fig. 2, in which *a*, *b*, *c* and *d* represent bevel-gear segments, which connect the friction wheels and the lever for moving them is connected at *A*, so that no segment has to move more than one wheel.

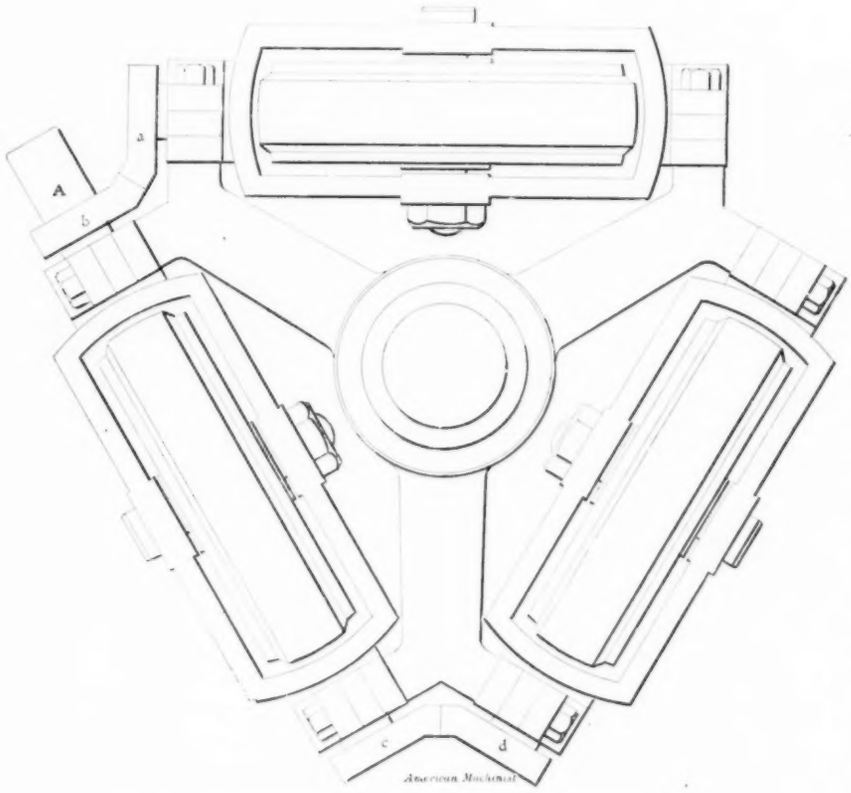


FIG. 2. ARRANGEMENT OF ROLLERS IN SPEED CHANGING PULLEY.

Fig. 3 is a longitudinal section showing how the device is arranged to act as a loose pulley. Here the belt runs on at *B* and normally this pulley is pressed against the friction wheels by the heavy spring *S*, the thrust bearing having a ball collar as shown. When the machine is to be stopped the shipper, instead of shifting the belt, simply compresses the spring *S* and relieves the friction wheels of pressure, allowing *B* to run loose on the shaft without imparting motion to *C*. The lever is forked to allow it to pass around the shaft.

Since the engraving was made we have received, too late for use, a drawing from the makers, showing some improvements, mainly in the provision of an oiling arrangement for the friction wheels, by which the studs are made hollow and a grease cup attached to the outer end of each one of them. The Auburn ball thrust bearing is now used instead of the one shown.

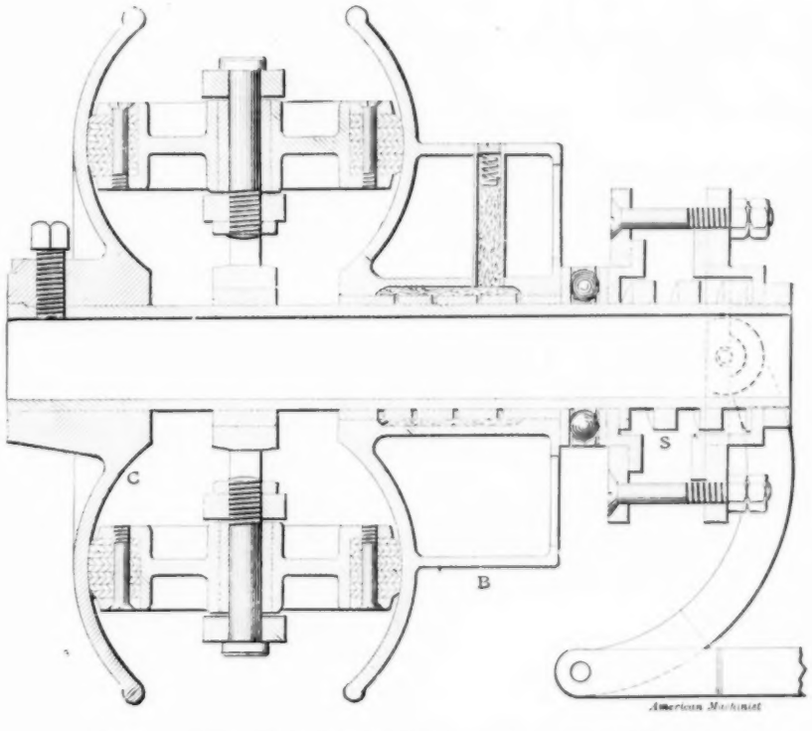


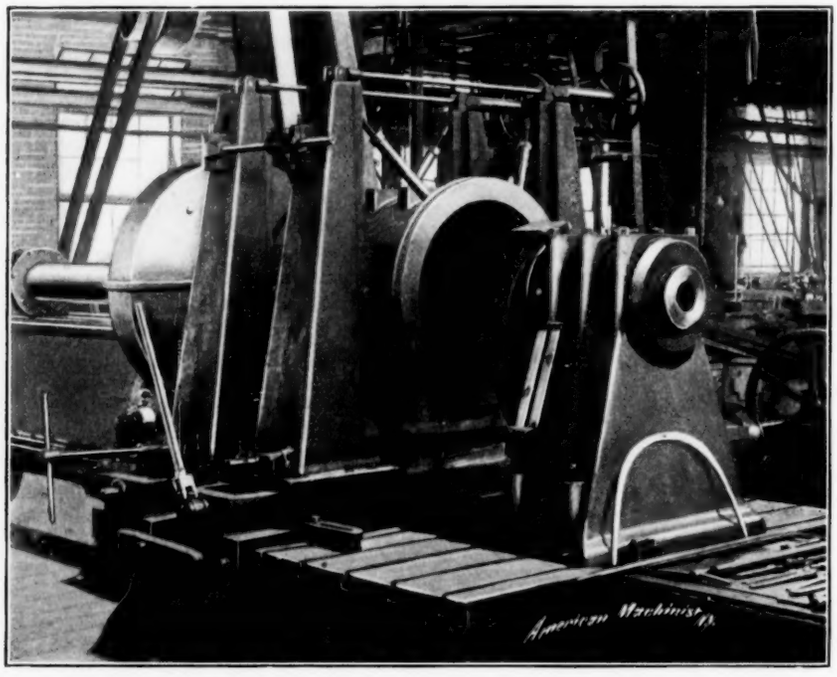
FIG. 3. LONGITUDINAL SECTION THROUGH SPEED CHANGING PULLEY.

Doerr Safety Bulkhead Door System.

A party of press representatives were entertained at lunch, January 3, on the new steamship "Kronprinz Wilhelm," of the North German Lloyd Steamship Company, at her pier in New York. The occasion was arranged to afford opportunity for inspection of the new Doerr system of bulkhead doors with which the ship has been fitted. The vessel is divided into some seventeen compartments connected by water-tight doors both below and above the water line. Those below the water line may be closed automatically from the bridge, through hydraulic power. Those above the water line are closed by hand upon signal from the same point. In the pilot house on the bridge there is a sort of annunciator board containing a plan of the ship, with bulls-eyes representing the bulkhead doors. When any door is shut it closes an electric circuit and lights up the corresponding bulls-eye. The party were conducted into the sub-aqueous regions of the ship among the engines, where one of the doors in a longitudinal wall was shown in operation. The aperture, in this part of the ship, was small and the door was let down on the principle of a guillotine. To prevent its acting as such on any of the engineers who happens to be passing through, signal bells ring for about twenty seconds and the slide falls slowly. There are several ways in which these doors may be closed—for instance, from the bridge, as explained; from the engine-room, by hand, or by their own weight. Another safety device on the vessel is a fire indicator on the bridge, which shows in just what region the fire is located.

Device for Holding Cylinders for Boring.

The half-tone shows a cylinder mounting for a large horizontal boring mill. It consists mainly of two pairs of columns, each pair on a separate bed. The columns or jaws are moved toward or away from the center by powerful screws, a ratchet wrench being seen on the front end of one of them. The screws meet in the center of the bed and are connected there by a clutch, so that the columns may be moved together or independently as desired, the screws of course being made right and left. Wedges are provided for vertical adjustment with screws operated by a socket wrench seen at the extreme left. A device is provided for liberating the wedges and allowing them to remain stationary, while, if necessary, the columns are moved. One pair of columns may remain stationary while the other pair



ADJUSTABLE MOUNTING FOR BORING CYLINDERS.

are moved and adjusted to suit the length and diameter of the work. After work has been set the tie rods shown in front of the columns near the top are firmly locked by split clamps, as are also the binder cross rods shown at tops of the columns, the latter by means of hand wheels at the back. Each pair of columns is independent of the other, and work of any size may be chucked regardless of the size of the work at the other end, or in the other pair of columns. The cut shows the mounting at work. It has been giving satisfaction for a year or more in a large shop in New England. It was designed by E. D. Becker, of Boston, Mass.

A writer in "Engineering" says that English steel makers seem to have nearly a monopoly of the American tool steel market.

Case Hardening Wrought Iron and Machine Steel.

BY E. R. MARKHAM.

Hardening the surfaces of articles made of wrought iron and machinery steel is generally termed case hardening. Most machine shops have some means whereby they can harden screws, nuts and similar small articles. Where there are only a limited number of pieces to harden it is customary to heat the work in the blacksmith forge, in a gas jet or in any place where a red heat can be given the piece. When hot sprinkle a little granulated cyanide of potassium, or a mixture of prussiate of potash, sal ammoniac and salt; reheat to a red and plunge in clear cold water. When there are large quantities of work to harden this is an expensive as well as a very unsatisfactory way.

To case harden properly we must understand the material of which the article is made and the purpose for which it is to be used, whether it is simply to resist wear or friction, will be obliged to resist sharp or heavy blows, a bending or twisting strain, or do we wish merely to produce surface colors?

We will first consider the case hardening of work that simply needs a hard surface with nothing else to be taken into consideration. Pack the articles in an iron box made for this purpose, using a mixture of equal parts by measure of granulated rawbone and granulated charcoal mixed thoroughly together. Cover the bottom of the hardening box to a depth of 1½ inches with the mixture, pack a row of work on this, being sure that the articles do not come within ¼ to ½ inch of each other, or within 1 inch of the walls of the box. Cover this with the packing to a depth of ½ inch, tamp down, put on another layer, and so continue until the box is filled to within 1 inch of the top, filling the remaining space with refuse packing material left from previous hardenings, if we have it; if not, fill with charcoal or our packing material. Tamp well, put on the cover and lute with fire clay, to prevent as much as possible the escape of the gases. If the articles are so large that they would not cool below a red heat before reaching the bottom of the bath, they should be wired before putting in the hardening box. We should use iron binding wire sufficiently strong to hold the work when it is worked around in the bath. If the articles are too heavy for wiring, we must devise some other way of holding, either tongs or grappling hooks. If the pieces are small they can be dumped directly from the box into the tank, sifting the work out of the box somewhat slowly, so that the articles will not go into the bath in a body. If the tank is large enough it is a good plan to have wires across from side to side about four inches apart in the horizontal rows. Have the rows three or four inches apart and do not put the wires underneath each other, but in such a manner that the work will strike the different wires as it passes to the bottom of the tank. In striking these wires the work will be separated and any packing material adhering to it will be loosened by the jar; the work will also be turned over, thus presenting all sides to the cold water as it passes through.

These wires can easily be arranged (see sketch) by taking two pieces of sheet metal a little shorter than the inside length of the tank, drilling holes in them as described in the arrangement of the wires and the wires can be passed through these holes and riveted, thus making a permanent fixture that can be placed in the tank and taken out at will. The distance between the wires can be varied to accommodate the particular kind of work we are to do; they must be far enough apart so that the work cannot lodge on them. Anyone troubled by the case hardening being soft in spots will find a remedy in this simple device. Do not have any wires within 8 or 10 inches of bottom of tank. Have a coarse screen or a piece of sheet metal drilled full of holes somewhat smaller than the pieces we are to harden; block it up about 2 inches from the bottom to allow a free circulation of water underneath it. This also allows the water to pass through it around the work, and the packing material will pass through it, leaving the water a better chance to get at the work. The water inlet should be at the bottom of the tank and we should have an outlet about 2 inches from the top to allow the surface water to escape. The cold water coming up from the inlet at the bottom should be turned on before we dump the work, allowing it to run until the work is cold.

In heating the work any form of furnace will do that will give the required heat and

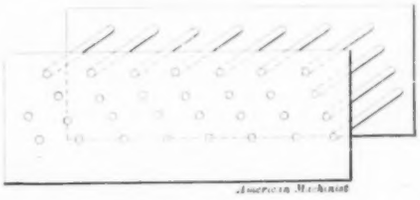
maintain it evenly for a sufficient length of time. The covers of the boxes should have several ¼-inch holes drilled near the center. After putting the cover in place, put pieces of 3-16 inch wire through these down to the bottom of the box, allowing them to stick up an inch above the cover, to enable us to get hold of them with the tongs. When it is thought that the work has been in the fire long enough to heat through draw one of the wires with a long pair of tongs or take an ordinary pair and put some pieces of gas pipe on the legs. If the wires are red the entire length we time from them, and, if not, we wait a few minutes and draw another, and so on until we draw one red the entire length. I consider this the proper method to employ in timing all work in a fire, whether it is to be annealed or case hardened, charging for hardening by the Harveyizing method or when we are pack hardening tool steel. If we time our work from the time we put it in the fire we are uncertain as to the results if the fire is hotter one day than it is another. Some days our fire acts dead, another day lively, so our pot is longer in heating at one time than another; but if we time from the period when our work commences to take carbon, we will have results as nearly uniform as it is possible to get, provided we have a uniform heat, which can be gaged quite closely by the eye. Better results can be obtained by use of the pyrometer, although for ordinary work this is not necessary.

After running the proper length of time in the fire, which varies according to the nature of the steel and the purpose for which it is intended (small articles, ¼ inch or less, which do not require anything but a hard surface should be run from one to two hours after they are red hot), dump into water. If it is desirable to have them colored somewhat, hold the pot about a foot or 18 inches above the tank, allowing them to pass this distance through the air before striking the water. If we are hardening small screws with slots for screwdriver, and are hardening simply to keep the screwdriver from tearing the slot, we can use expended bone; that is bone that has been used once before. It will make the work hard enough for all practical purposes, yet not hard enough to break. If we wish to harden deeper we must run longer. To harden 1-16 inch deep it is necessary to run about five hours after the work is red. By running sixteen to twenty hours we can harden to a depth of ¼ inch. In the case of small articles it is best to use a bone not coarser than what is known as No. 2 granulated raw bone. When we are to run for a long period of time in the oven, we should use a coarser grade. The charcoal used in the mixture should, if possible, be of the same sized granules as the bone. The commercial article is much superior to anything we can pound and sift, so that it is policy to buy it. The first cost may seem a little stiff, but if account is taken of the time it takes to grind and sift, we will find the article we buy the cheaper.

There are many special preparations used in case hardening, some of which are excellent for special work, while some are good for all kinds of work. When we wish to harden deep in a short space of time it is advisable to use bone black in place of granulated raw bone. Bone black —or animal charcoal, as it is commercially called—is prepared by burning bones in a special furnace. It comes in the form of a powder; it leaves a finer grain in the work hardened, and will make it stronger than if hardened with raw bone.

Another form of bone which gives excellent results is called hydrocarbonated bone, a form of bone black treated with oil, so that it gives off its carbon more readily than either form mentioned before. It is not generally used, but for very nice work it is very satisfactory.

If we wish to give a nice color to our work it is necessary first to polish it and to be sure it is clean when packed in the hardening box. Use the following mixture when packing: 10 parts No. 1 granulated raw bone, 2 parts bone black, 1 part granulated charred leather; mix very thoroughly before using. The results will be much more gratifying if we pipe into our bath, placing the end or outlet near the bottom. By means of an air pump of some description force a jet of air into the water in such a manner that it will be distributed throughout the whole tank, in order that each piece of work may come in contact with the air as it passes through the water. When articles are hardened by the first process mentioned, heating in fire and treating with cyanide of potassium, very nice colors can be obtained by taking a piece of pipe, putting it in the bath and blowing through it, passing our work through the air in the water when we dip it.



WIRES FOR SCATTERING SMALL ARTICLES IN HARDENING.

When the articles are thin and must be very hard yet tough, it is best to use a bath of raw linseed oil. If this bath is used it is advisable to attach a piece of iron binding wire to each piece when we pack the work, allowing the wires to hang over the sides of the box. When we remove the box from the fire the articles can be removed from the box and immersed in the oil by means of the wires. They should be worked around well in the bath until the red has disappeared, but in such a manner that broad sides are not moved against the cold oil, or the article will be liable to spring. In the case of a long, slender piece work it up and down, moving sideways each time, so as to come in contact with cool oil and get away from the vapors that are formed, as they hold the oil from the work, thereby preventing hardening.

In many shops it is customary to make snap gages of machine steel. They are much easier made, the cost of material is less, and if hardened properly they will wear well. It is best in cases of this kind to use open-hearth steel rather than Bessemer, as the latter runs so uneven. When charging in the furnace, some pieces will harden to a depth of 1-16 inch if run four or five hours, while another piece 1 inch thick will harden entirely through in an hour. Open-hearth steel runs very uniformly when hardening, according to my experience. The best results will be obtained if we use granulated charred leather instead of bone. When packing mix with an equal amount of granulated charcoal, run five or six hours if the gage is ¼ inch thick or over. Run at a very low heat and dip in the oil bath; it will be found to be very hard, and probably straight.

In hardening small pieces it is advisable to use a small box, as it takes some time to heat a large box through; the pieces on the outside will be much harder than those nearer the center. After hardening we should dry the bone used in packing. It is not only useful for packing articles we do not wish very hard, but is excellent to use when annealing cast iron that will not soften when packed in clear charcoal.

The Corliss Valve Gear.

BY J. BEGTRUP.

Four separate valves are used, two at each end of the cylinder, one for steam and one for exhaust. The exhaust valve is simply a cylindrical slide with a reciprocating rotary motion, and it may be described as a flat valve bent to a cylindrical form.

The same would be true of the steam valve, but on account of a special valve gear, its action becomes different from that of an ordinary slide valve.

If all four valves were positively driven by one eccentric the steam distribution would be exactly like that of a common D-valve—it would be the D-valve dissolved in its four component parts.

But the four-valve system has points of superiority not possessed by the single combination valve.

1. Steam and exhaust passages become short and direct.

2. The valves are not balanced, but the unbalanced pressure will be only that due the difference between the pressure in the cylinder and that in the adjoining steam and exhaust chambers, and the full effect of this will be intermittent and on the port area only.

3. The separation of the valves makes it possible to reduce the valve motion by means of toggle motion of the valve rods. The port must be covered during one-half the period of rotation at least, and if the motion of the valve is the same in opposite directions from a central position, as it must be with the D-valve, the greater part of the motion must generally occur after the port is closed. This can be avoided when the valves are separate, for then each valve may be separately attached to a special rocker or wrist-plate in a manner to produce a reduced valve motion during the exhaust period.

CORLISS VALVES.

Fig. 1 represents diagrammatically the Corliss valves and wrist-plate connections for one end of the steam cylinder. It shows how the toggle motion of the radius rods operates to reduce the movement of the valve after the port is closed. As the angular motion of the valve is reduced by the toggle action, it becomes possible to use smaller valves than otherwise practicable, because a given angular valve motion yields a larger port opening than could be had with a straight motion of the rod.

Figs. 2 and 3 show the construction of the first Corliss valves. The valve stem has a flat extension which fits the whole length of the valve and has a journal at each end.

The Corliss steam valve, shown in Fig. 4, is a simple circular slide, suitably guided. The slide and the cylindrical parts at each end are now often cast in one piece, and the valve stem terminates in a T-head which fits in a slot across the end of the cylindrical part.

These valves are often double-ported to avoid the necessity of using large diameters or to reduce the motion. The objection to double ports is the increased clearance space they make. The clearance may be reduced to a minimum by putting the valves in the cylinder heads, and this would, no doubt, become the general practice if it did not involve somewhat complicated steam connections.

Double-ported steam and exhaust valves are shown in Fig. 5. Fig. 6 represents three-ported valves for the lower head of a 60-inch low-pressure cylinder of a cross-compound vertical engine, designed by Messrs. Rice & Sargent. The steam valve is held up to its seat by end gibs, supported by flat steel springs, and these are adjusted by means of screws from the outside.

The exhaust valve is a hollow shell with closed ends. It is separated from the bottom of the cylinder by a loose-ported valve-seat plate, the upper side of which is flush with the cylinder head. This plate is held freely between planed jaws in the cylinder head, and the steam pressure in the cylinder keeps it against the valve and prevents the steam from passing inside the valve when the ports are closed. The opposite side of the valve is provided with a single wide port and is always open to the exhaust chest. This construction gives less clearance than the ordinary Corliss exhaust valve.

The motion of the Corliss induction valve is quite different from that of a common slide valve. The special feature is a disconnecting device, which allows the valve to be closed by a spring or vacuum dash-pot or other independent agency. The eccentric moves the valve till it is released by the knock-off cam, and it is then closed by the dash-pot. The valve is perfectly at rest during the expansion period and the greater part of the exhaust period, but during the exhaust period it is caught by the steam hook and slowly started, so as to admit steam near the beginning of the forward stroke. The amount of opening and the period of admission depends on the position of the knock-off cam, and this is in turn determined by the speed regulator. When the steam-hook arm strikes the knock-off cam the hook is released, and the valve is closed by the dash-pot. The result is a nearly ideal valve motion.

LIMITATIONS OF THE CORLISS GEAR.

When a single eccentric drives both steam and exhaust valves the range of cut-off is limited to about half the piston stroke. This will become obvious by considering the following necessary conditions:

1. After the eccentric has reached the extreme of its throw in either direction all valve-gear motions are reversed.

2. The steam valve must be released before the eccentric motion is reversed, for if the hook does not strike the knock-off cam during its forward motion it cannot strike it during its return motion.

3. The maximum exhaust opening, or the middle of the exhaust period, must occur when the eccentric is at the extreme of its throw.

Now, in order to get release of the expanded steam in the cylinder before the commencement of the return stroke and exhaust closure a little before the end of the return stroke, the middle of the exhaust period or the extreme of the eccentric must evidently occur before the middle of the return stroke, and therefore, the extreme throw of the eccentric in the opposite direction must occur before the middle of the forward stroke, and the valve must be released before that point is reached, if released at all.

The point where steam is cut off is not coincident with the action of the cut-off cam, for it takes some time to close the valve. With a long piston stroke the closing period is comparatively short, but it is far from being "instantaneous," as seems to be the prevalent impression. The return motion of the valve and dash-pot starts comparatively slowly—as indeed all motion does—but this slow motion is not observable on account of the shortness of the interval, and by overlooking this fact a false conception of the dash-pot action is formed.

A good vacuum dash-pot closes the valve in about one-sixteenth of a second at late cut-off, or during one-twelfth of a rotation. If the engine makes eighty turns per minute, the closing motion will in that case cover about one-sixth of the stroke. With short stroke and high piston speed the latest cut-off would be much later than mid-stroke.

The releasing gear is seldom used on high-speed engines because the sudden and frequent action will cause it to wear quickly and become unreliable, and as a sharp cut-off is not attainable at high speed, there is not sufficient justification for the use of a somewhat complex and delicate gear. One hundred turns per minute may be assumed as a practical limit for the Corliss gear.

This speed limit of the Corliss gear is of no consequence in connection with large engines, where great piston speed may be obtained with less than one hundred turns per minute, and, for obvious reasons, in such cases simplicity or fewness of parts is a consideration of less moment.

It will be understood from the foregoing that late release and late exhaust closure are conditions imposed by the single eccentric valve gear, and these conditions agree very well with moderate piston speed; but at higher speed earlier release and more compression may be required.

This may be effected by moving the eccentric forward on the shaft, but the reversing of the steam-hook motion would then also occur at an earlier stage of the forward stroke, and the range of cut-off would be correspondingly shortened.

Earlier exhaust closure could be had by giving the exhaust valve more lap, but this would involve a later release of the expanded steam at the end of the forward stroke. On the other hand, shortening the exhaust lap would give earlier release but insufficient or no compression.

THE SINGLE-ECCENTRIC VALVE DIAGRAM.

Let the circle, Fig. 7, represent the path of the center of the eccentric, turning in the direction shown by the arrow, and let the horizontal diameter represent the throw of the eccentric. When the center of the eccentric is at point 1 the steam port opens, and if the valve is not released before the end of the throw at point 3, the port will close again at point 4. The exhaust port opens at point 6 and is closed at point 9. The crank is supposed to be at its dead center *C* when the eccentric is at point 2, just after opening the steam port. When the crank is on the opposite dead center the eccentric must be at point 7 diametrically opposite point 2, and the point of release, at 6, occurs a little before this, as it should do. Arc 1—2 represents

period of steam lead, arc 6—7 represents period of exhaust lead, and arc 9—1 represents the compression period. When the eccentric is at point 3 the valve-gear motion is reversed, and the crank has not yet arrived at point 10. The valve is therefore necessarily released before mid-stroke, if it is released at all. Note that the chords must be parallel if there is only one eccentric, and that in order to get release before the end of the stroke, the diameter 2—7 must cross the chord 6—9. If, in order to extend the cut-off, point 2 be moved back to point 10, the diameter 10—5 could not be made to cross the exhaust chord in any position, and release would then take place after commencement of the return stroke.

This simple diagram fully illustrates the limitations of the single-eccentric valve gear, but it may be profitable to turn the figure and let diameter 2—7 represent the stroke of the piston, and let the circle represent the path of the crank-pin. Points 1, 2, 3, . . . will then mark significant positions of the valve gear in proper *relation to the piston stroke*, and an imagin-

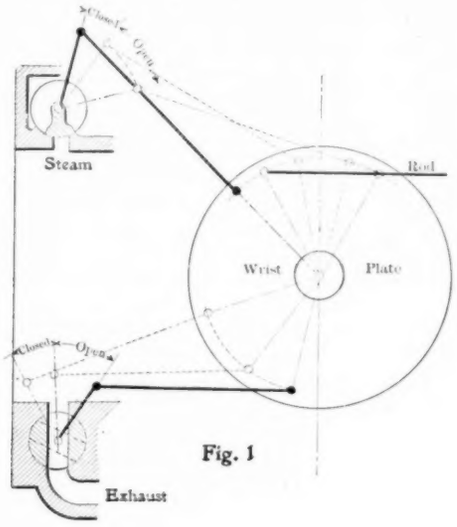


Fig. 1

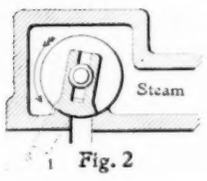


Fig. 2

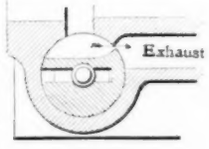


Fig. 3

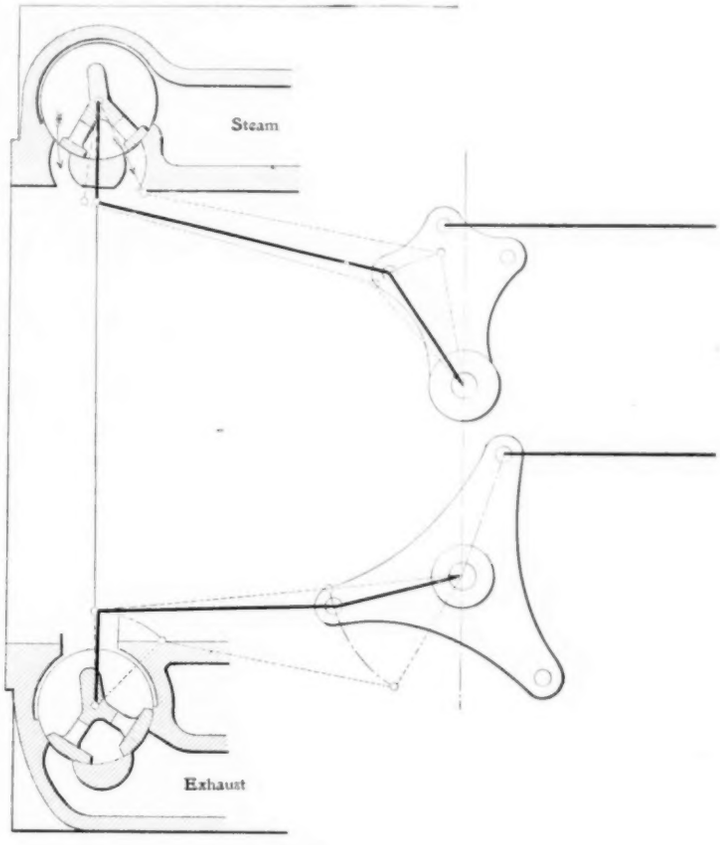


Fig. 5

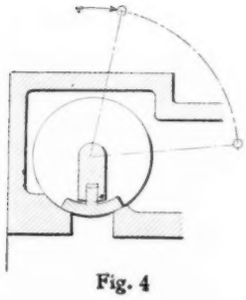


Fig. 4

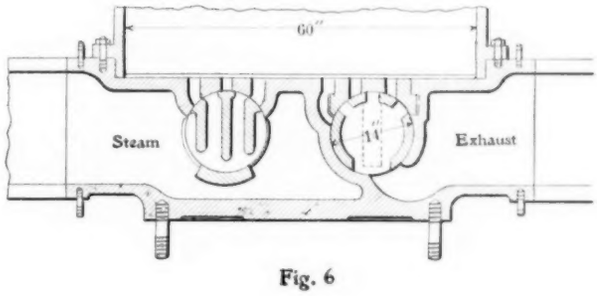


Fig. 6

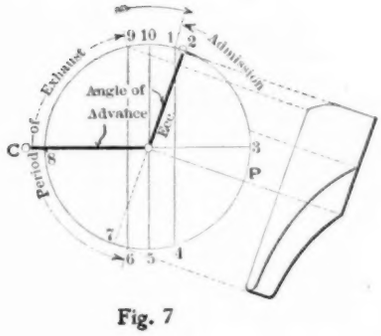


Fig. 7

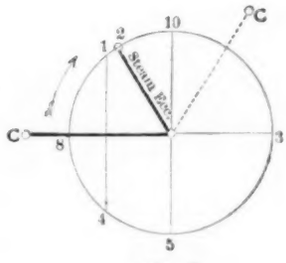


Fig. 8

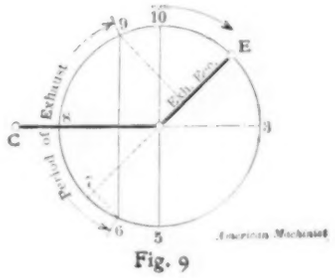


Fig. 9

THE ACTION OF THE CORLISS VALVE GEAR.

ary indicator diagram may be constructed, as shown. Note that by this arrangement the position of the eccentric relative to the crank is not considered; but it clearly shows the result when the eccentric is moved forward on the shaft, in which case the whole cycle of events occurs earlier in the stroke—that is, the lead is increased, the range of cut-off is diminished, and there will be earlier release and more compression.

The steam hook connects with the valve at or near the end of its throw, and the eccentric motion 8—1 determines, therefore, to what extent the valve must overlap the steam edge of the port when at rest.

Note that during this period the valve should move as little as possible (distance 1—8, Fig. 2), and the radius rod must, therefore, have considerable lateral motion before the valve opens. When the wrist plate is in its central position the eccentric is at point 10, and the lap of the steam valve in this position is determined by the eccentric motion 10—1. The corresponding exhaust lap is determined by the eccentric motion 5—6. The exhaust chord 9—6 could evidently be moved to the other side of the center, in which case the exhaust valve would not cover the port at half throw; or the port could be placed centrally, which would make the exhaust period cover exactly one-half rotation, and would put the exhaust edges "line and line" in the half-throw position; but such changes would give earlier release and less compression. Lap and clearance can be laid out very accurately on the drawing board, and it should be marked on the drawing. The great adjustability of the Corliss gear makes it easy to set the lap by some rule of thumb after the engine is erected, and a little variation in the points of release and compression may not be of much practical consequence; but when a "good" indicator card is required there may later be some tedious resetting to do. There should always be marks at the end of the valve, inside the rear bonnet, in line with the steam edges of valve and valve seat.

At point 3 the valve motion is reversed, and if arc 3—*P* represents the period of dash-pot motion, arc 2—*P* will represent the admission period for latest cut-off, as determined by the knock-off cam, which in this case would be one-quarter of a whole revolution, or half of the piston stroke. But if under heavy load, the speed regulator puts the knock-off cam out of reach of the steam hook, the engine will take steam during period 1—4, or nearly full stroke.

TWO ECCENTRICS.

In order to obtain a greater range of cut-off in Corliss engines a separate steam eccentric is used, and has become quite common. With two eccentrics the admission and exhaust periods can be adjusted independently, and steam may be cut off anywhere, nearly to the end of the stroke.

In order to start the valve without shock, the hook must connect with it when near the end of its throw; and the steam eccentric may be so placed in relation to the crank that this connection is made near the end of the return piston stroke, for the valve need not overlap the port more than ½ inch when closed.

The arrangement of steam rods exemplified in Fig. 1 is in every respect satisfactory in connection with a single-eccentric valve gear; for in that case a slow initial valve motion is imperative, and it is obtained by the lateral movement of the radius rod. But with two eccentrics a quicker initial motion is feasible and desirable, and it may be obtained by reversing the valve motion and admitting steam over the top of the valve (Fig. 4).

Separate eccentrics require separate wrist plates, and their centers may be located one above the other, as shown in Fig. 5.

Figs. 8 and 9 show how the eccentrics may be placed on the shaft. The steam eccentric is at point 2, Fig. 8; the exhaust eccentric is at point *E*, Fig. 9, and the crank is at its dead center at *C*. Individual eccentric circles are shown for the sake of clearness, and the notation is the same as in Fig. 6. An imaginary motion of the eccentric arm will point out the various events. Referring to Fig. 8, near point 8, at the end of the throw, the hook connects with the steam valve; at point 1 the steam edges are on the point of separating, and the eccentric motion 8—1 determines the initial valve motion. When the eccentric is at point 2 the crank is at its dead center, as shown. At point 10 the steam wrist-plate is in its central position, and in that position the valve does not cover the port, as with the single-eccentric gear, but the port is open to a certain extent, determined by the eccentric motion 1—10. Point 3 marks the end of the throw, and the corresponding position of the crank is at *C'*, at about three-quarters of the piston stroke, and the limit of cut-off is a little later. If the hook does not strike the knock-off cam the valve will remain open till closed by the return stroke of the eccentric at point 4, near the middle of the return piston stroke.

The exhaust action is discernible from Fig. 9. It is similar to the single-eccentric action, but with this difference, that the release, at point 6, occurs at about 90 per cent. of the stroke, and the exhaust is cut off at about 70 per cent. of the return stroke, at point 9. The motion of the exhaust valve after it has closed the port is determined by the eccentric motion 9—3—6, and full port opening is obtained by the eccentric motion 6—8. The motion 9—10 determines the exhaust lap when the wrist plate is in its central position.

A valve gear designed to be operated by a single eccentric cannot very well be made to cut off much later than at half stroke, even when a separate exhaust eccentric is added. For the slow initial valve motion requires at least half the throw of the eccentric, and the other half is not sufficient for a late cut-off; and it will readily be seen from an inspection of Figs. 1 and 5 that a quicker initial valve motion in Fig. 1 would involve radical changes in the valve gear. However, the range of cut-off may be extended some by moving the eccentric back, sacrificing the lead; and to this there is no objection when it does not involve later release. The advantage gained by a second eccentric would consist in more compression and easier release.

CORLISS VALVE DIMENSIONS.

The steam and exhaust ports of Corliss engines are usually made as long as the cylinder bore, and steam and exhaust valves are usually of equal diameters, but the diameters do not vary as the bore of the cylinders, as might be anticipated. The proportion varies from one-third of the bore, in small engines, to one-sixth for large low-pressure cylinders. The ports are not necessarily proportioned according to the diameter of the valve, but the port opening will be nearly so. It is considered a safe rule to make the width of port sufficient to allow a mean velocity of 8,000 feet per minute of the entering steam, and 6,000 feet per minute of the exhaust, but a smaller port area may consistently be allowed for large cylinders. The port opening is in proportion to the travel of the valve, which is practically limited by the diameter.

DIRECTIONS FOR SETTING THE VALVE GEAR.

Adjust length of eccentric rods to give wrist plate equal travel on both sides of center-mark on bracket. Adjust length of radius rods to give proper lap with wrist plate in its central position. Move wrist plate to end of its travel either way (as marked on bracket), and adjust length of drop rods to let the hooks freely engage the catch blocks. Put crank on dead centers, and set eccentric ahead of the crank, sufficient to give the proper lead. Raise governor to highest working position and adjust length of rods so that the knock-off cams will just keep the hooks off the catch-blocks.

Smoke Abatement in Cleveland.

BY PROF. C. H. BENJAMIN.

The city of Cleveland has the somewhat unenviable reputation of being one of the smokiest cities in the United States. A careful canvass of the city shows over 1,000 different plants, operating in all over 2,000 steam boilers, whose furnaces discharge the products of combustion through more than 1,600 chimneys. Of this entire number 375 furnaces are fitted with mechanical stokers, 103 with down draft or other smokeless grates, 82 with automatic draft regulators, either with or without steam jets, while 145 are burning smokeless coal. This gives a total of 705, or about one-third of the total number, which can be considered unobjectionable from

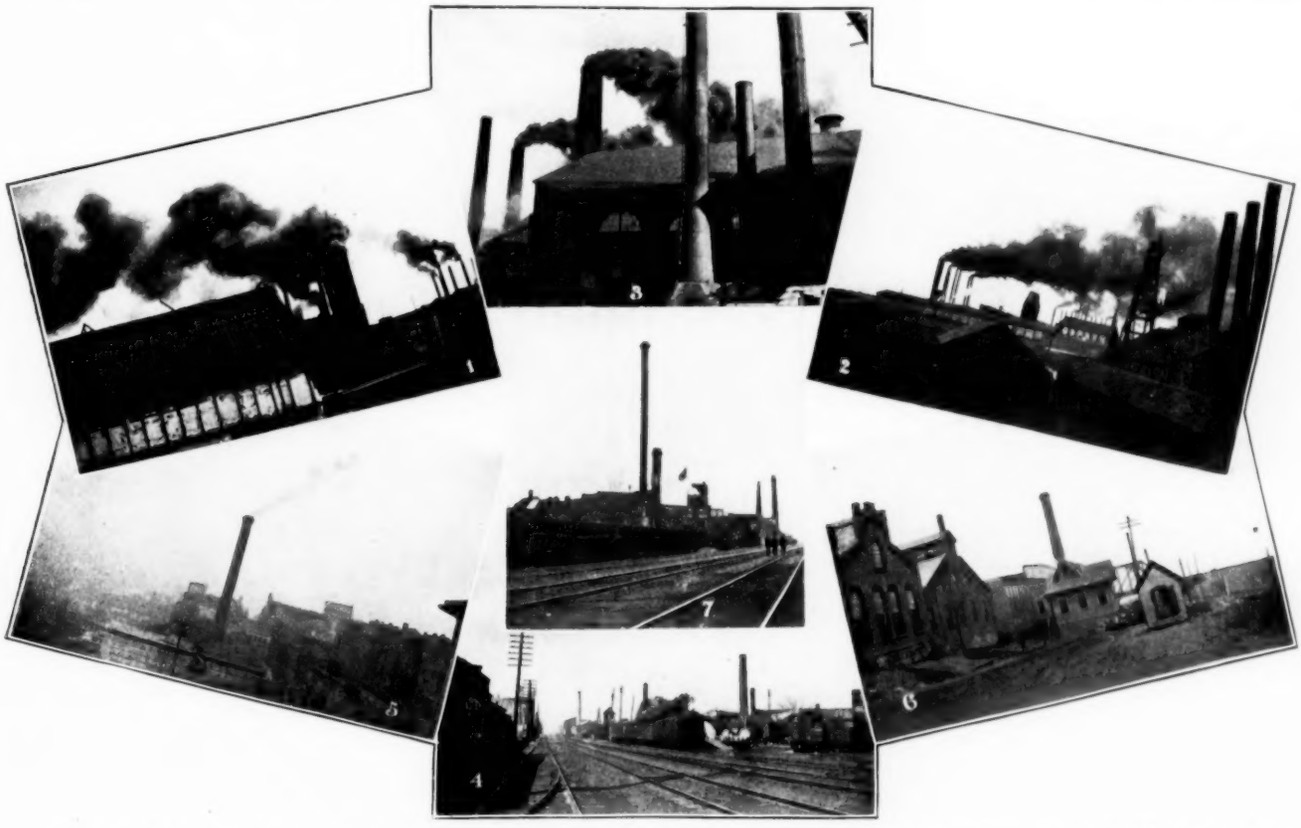
the smoke inspector's standpoint. Systematic observations of the various chimneys show that of the 1,600 mentioned more than 300 are to-day throwing out, on the average, more than 10 per cent. of black smoke; this amount of smoke in a manufacturing district being taken as the limit which can be allowed without serious criticism.

In the business section of the city more than 5 per cent. would be considered a nuisance. The conditions now, however, are not as bad as they were a year ago, and in proportion to the amount of work being done, and the amount of coal burned, Cleveland is cleaner to-day than at any other period in her history.

During the dark days of 1894 and 1895 the police department, and sanitary policemen were supposed to keep one eye on the garbage can and the other on the top of the chimney. The record book kept at this time by the department is decidedly amusing reading. Notices were frequently recorded, giving thirty or sixty days' time for abatement, and the final record in nearly all cases was "partially abated"; just how much this meant, those who have studied the subject can readily tell. Some arrests were made, and some cases went as far as the police court. Usually defects in the ordinance resulted in the dropping of the case. Occasionally test cases were continued from year to year, some of them landing in the Supreme Court of the State, and in one instance at least the engineer died before a decision was reached, while in one other the ordinance was declared unconstitutional about a year after it had been crossed off the municipal code. The only apparent result from this system of petty persecution and ill-considered legal action was a feeling of annoyance and antagonism on the part of the manufacturers and a certain contempt for the whole subject. At this time smoke abatement was considered more a joke than a matter of serious importance. There is no doubt that fifteen years ago the successful prevention of smoke was more or less problematical; most of the mechanical stokers were then in an experimental stage, and were rather unsatisfactory, while the host of so-called smoke annihilators were of so unreliable a character, and so manifestly frauds, as to prejudice all who had anything to do with them.

About the first of May, 1900, through the efforts of the Municipal Association of Cleveland, an amendment to the statute law of the State was effected, creating a separate division of the city government which should have this matter in sole charge. The law provided that the supervising engineer should be appointed by the Mayor for a term of five years, the object being to give sufficient time for the success of the work without political interference. The law also provided suitable assistants for carrying on the work.

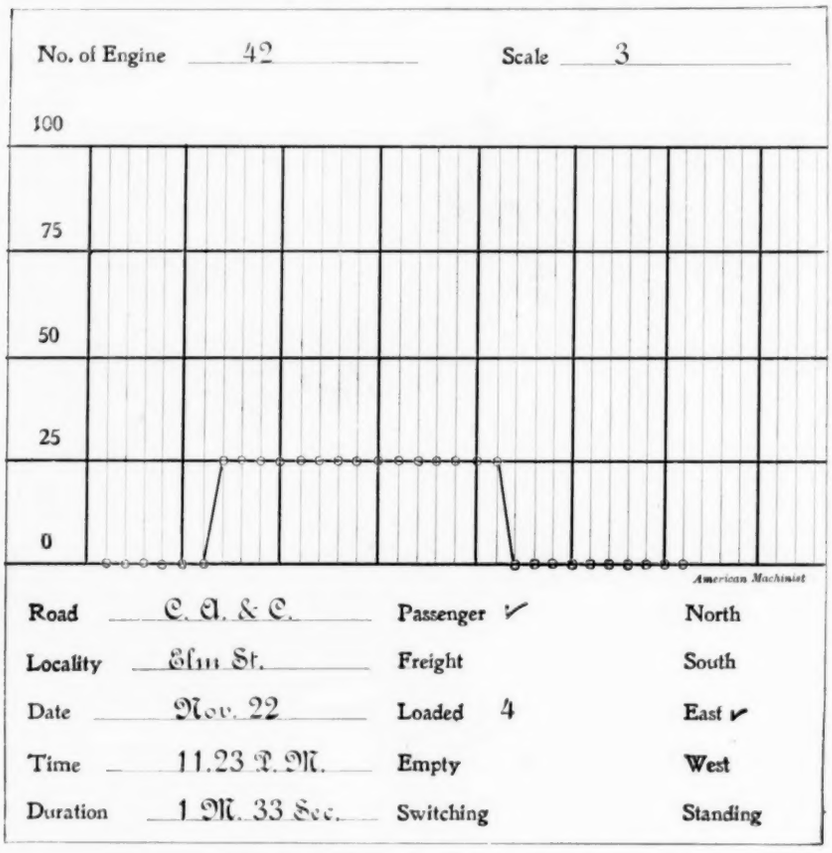
The writer entered upon the duties of his office about the first of August of that year. The first necessity was for a systematic organization of the work and an intelligent understanding of the conditions to be met. Accordingly a thorough canvass has been made of the entire city, and card indexes prepared showing the location of the various boiler plants and the nature of their equipment. As fast as this work was completed for any section of the city, regular observations were made of the conspicuous chimneys in that locality to determine which were the principal offenders, and to what extent. In grading the smoke from the different chimneys no attempt has been made to use smoke charts, but entire reliance has been placed



1. United Salt Co., May 22. 2. American Steel & Wire Co., May 22. 3. Otis Steel Co., since equipped with Murphy stokers. 4. Dangler Mfg. Co., Babcock & Wilcox stokers. 5. Cleveland Electric Illuminating Co., American Underfeed stoker. 6. The Hill Clutch Co., Babcock & Wilcox stokers. 7. Cleveland Cap & Screw Co., Babcock & Wilcox stokers.

there was probably less than now, but at what cost this kind of prevention was secured, Cleveland manufacturers know too well. For the past fifteen years there has been more or less agitation of this subject by public-spirited citizens. A "Society for the Promotion of Atmospheric Purity," although handicapped by its name and by the absence of technical knowledge on the part of its membership, certainly did much to arouse public sentiment in regard to the smoke evil. Numerous ordinances were passed by the City Council making the production of smoke a misdemeanor and establishing fines as a punishment. The control of the subject was vested in the public health division of

on the judgment of the observer. As one assistant has done nearly all of this work, he has become so expert as to give the relative readings very closely. One hundred per cent. is taken to mean dense black smoke of the worst variety, such as may be seen by referring to Figs. 1 to 3. In estimating the amount for a chimney, quality is graded rather than quantity, it being assumed that a small chimney which is pouring out dense smoke is just as guilty as its larger neighbor under the same conditions. Before making an average, at least one hundred observations are taken from each chimney at five-minute intervals, the total time covered usually being from 8 o'clock in the morning until 4 o'clock in the afternoon. Fortified with



SMOKE INSPECTOR'S BLANK AS TURNED IN TO THE OFFICE.

an accurate knowledge of the relative smoke conditions in each locality, the supervising engineer and his assistants, either by letter or by personal visits, can present the subject intelligently and can criticise each place with good assurance.

Perhaps the most potent argument for bringing about improved conditons is that of fuel saving. The saving which results from perfect combustion (a synonym for smoke prevention) is not a matter of theory but of every-day experiment. Careful tests made by experts in the employ of large manufacturing firms in Cleveland have shown a saving of from 15 to 25 per cent. by the use of smokeless furnaces, as compared with the ordinary firing on flat grates. These tests have been further verified by comparison of the coal bills for long periods of time. In one instance which has recently come to my notice, the installation of automatic draft regulators inducing perfect combustion by the abundant supply of oxygen immediately after firing has more than paid for the whole expense of the installation in one year, as shown by actual coal bills for the years preceding and following the date of installation. This saving can be traced to two principal causes: First, the uniform supply of coal combined with a uniform supply of air, giving a practically perfect combustion at all times and preventing the escape of carbonic oxide to the chimney; second, to the fact that the absence of soot on the heating surfaces of the boiler gives a higher rate of evaporation and correspondingly better efficiency.

Many of the manufacturers and business men thus approached were undoubtedly influenced also by the desire to better the atmospheric conditions, and to make their city a more desirable place of residence. But when atmospheric cleanliness and economy of fuel arrayed themselves on the same side of the question the problem was much simplified. Besides urging the desirability of a change in furnaces, we have also insisted upon more careful firing and have found it easy to demonstrate that running a lighter fire with frequent firing of coal in small quantities would result in more steam and a better condition of affairs generally. Careful attention to this matter of firing and to the conditions of such apparatus as was in use has reduced the smoke in several localities to about one-fourth of its former volume without change in the furnace or grates. The office of this department is a bureau of information on the subject of stokers and improved furnaces where catalogs can be obtained and where blueprints showing various appliances of stokers to boilers are on file.

The increase in the number of smokeless furnaces since the beginning of this work is a good index of progress. During the year ending July 1, 1901, one hundred and seventy-two satisfactory furnaces were either installed or contracted for. In eight new power plants built during this time containing from one to six boilers each, mechanical stokers were installed. Only two plants were built during the year without the installation of stokers, and in one of these stokers have since been introduced. Since the date last mentioned fourteen firms have already installed over sixty stokers or smoke preventers of various sorts.

It would be unfair to the manufacturers themselves to say that all of this improvement was due to the efforts of this department, but undoubtedly the steady pressure brought to bear had its effect.

There are to-day in Cleveland a large number of establishments whose chimneys refute the oft-repeated assertion that smoke prevention is impossible. The chimneys of the Cleveland Twist Drill Company, the Hill Clutch Company, Cleveland Cap Screw Company, Dangler Manufacturing Company, and others such as shown in Figs. 4 and 5, etc., show usually only one or two per cent. of smoke throughout the day. In fact, they are so free from this nuisance that their tops are scarcely sullied. These enterprising firms are also comforted by the fact that it pays to be good.

While the great bulk of the hydrocarbons comes from the chimneys and stacks of factories and mills, the smaller quantity which issues from the smokestacks of locomotives is sometimes more annoying to those in the neigborhood. The stacks of the engines are so low and the smoke is so thoroughly distributed along the right of way that it does more damage in proportion to the quantity.

In some Eastern cities, I believe the laws compel the use of coke or hard coal within the city limits. It has seemed impracticable to enforce an ordinance of this character in Cleveland at the present stage of the movement. Locomotive engineers, however, have one great advantage in the ever-present forced draft, which makes possible a better air control. Experiments on some of the Southern and Western roads have shown conclusively that firing with one or two shovels of coal at short intervals and leaving the door ajar an inch or two after firing would almost eliminate the smoke.

The officials of the railroads entering Cleveland, at the request of the writer, issued stringent instructions to firemen and engineers both on the railroads and in the yards insisting upon light and frequent firing with suitable attention to the door and to the blower. One of the assistant engineers, a competent railroad man, has since devoted all of his time to inspection of the locomotives, having since March of this year made over fifteen hundred observations on about four hundred different engines, being about two hundred and fifty observations to each road. The smoke for an engine is graded from the time it becomes visible until it passes out of sight, readings being taken at intervals of from three to five seconds. The readings are jotted on a graphic log which is subsequently finished up in the office.

Almost daily reports to the railroads, containing duplicates of these cards, make it possible for the master mechanic and foreman of engines to call the engine crew to account for violation of the law while the circumstances are still fresh in their memories. The improvement thus effected by the combined efforts of the railroads and the city officials can be best shown by comparing the averages at the beginning and now. The averages on the six principal railroads entering Cleveland in March, 1901, were as follows: Cleveland & Pittsburgh, 28 per cent.; C., C., C. & St. Louis, 35 per cent.; Erie, 35 per cent.; N. Y., C. & St. Louis, 35 per cent.; L. S. & M. S., 34 per cent.; C., T. & Valley, 20 per cent. The averages on these same railroads for November of this year were: Cleveland & Pittsburgh, 8 per cent.; C., C., C. & St. Louis, 13 per cent.; Erie, 12 per cent.; N. Y., C. & St. Louis, 10 per cent.; L. S. & M. S., 11 per cent.; C., T. & Valley, 11 per cent. This reduction can be attributed entirely to the change in the method of firing, there having been no important modification of the furnaces during that time. There is, of course, a limit to the improvement that can be effected in this way, and to make even this improvement permanent requires continual oversight. It cannot be doubted, however, that it is well worth the trouble it takes, both to the city and to the railroads themselves; their object is not altogether a patriotic one, since the perfect combustion resulting from smokeless firing cannot fail to reduce the coal consumption.

To a man coming from one of the Eastern cities the conditions in Cleveland even now would seem almost insupportable. It is only by comparing what is with what might have been that we can take heart to go on.

At the present writing the outlook for smoke abatement is more encouraging than at any time in the history of the reform, and forces are working, not perhaps apparent to the casual observer, that are destined to effect a considerable revolution in the next two or three years.

Letters From Practical Men.

The Proposed Standard Roller Chain.

Editor American Machinist:

We are much interested in the letter from Mr. J. O. Nixon, of the Link Belt Engineering Company, on page 13, issue No. 1, of your journal, and are pleased that another company has commenced to agitate this question of roller chain standards. We consider the matter of sufficient importance to warrant a meeting of automobile and chain manufacturers for the purpose of discussing the subject from every standpoint.

The points mentioned by Mr. Nixon do not change our ideas with regard to sizes of rolls, rivets, etc., but we agree with him that no standards should be adopted unless it can be shown by test that they are the best. We agree with Mr. Nixon also that sprockets should be cut to give a clearance for the chain rolls. We do not know the exact amount necessary, but are making a study of this point and hope with the assistance of interested automobile manufacturers we may learn something in the near future that will be of value.

The Brown & Sharpe Manufacturing Company has been furnishing sprocket cutters for our new line of roller chains, and we are sure they will be glad to make any improvements which may be shown by demonstration.

Mr. Nixon states, "I do not believe that large rivets are necessary for strength, as chains with much smaller rivets will fail in the side bars." If he will reconsider, we think he must admit it is a very easy matter to use side plates which will shear the rivets, and therefore the size of the rivet determines the strength of the chain.

Our ¾-inch pitch chains have the same size rolls as used in other ¾-inch pitch chains. Before making chains larger than ¾-inch pitch, we had one of this size severely tested for months on a steam carriage weighing 1,800 pounds. The chain and sprockets gave entire satisfaction, and we imagine they will continue to do so for some time.

If the ¾-inch pitch chain will give good satisfaction for a long time on vehicles 1,800 pounds or less, what will be the results obtained by using a 1-inch pitch chain of our standard on the same machines? The sprocket teeth for our 1-inch pitch chain are thicker and will therefore admit of more clearance, if desirable, and the rivets are as large as used in other chains 1¼-inch pitch. We can see but one answer to this question, namely, the 1-inch pitch chain must give excellent results. We believe this same argument applies to our 1¼ and 1½-inch pitch chains. The large rivets must lessen elongation, as acknowledged by Mr. Nixon, and by lessening elongation the amount of tooth clearance necessary is reduced.

We believe a thick roller will revolve better than a thin roller and a large roller which revolves will wear the sprocket teeth much less than small thin rolls.

For example: Imagine a wheelbarrow with an axle 3 inches in diameter and wheel 12 inches diameter. When pushed along a dirt path, the wheel will revolve on the axle and roll on the path. If the wheel should be replaced with a roll 3¼ inches diameter we believe the roll would refuse to revolve.

If Mr. Nixon is correct in his idea that thin rolls are as good as thicker rolls, we could reduce the diameters of our rolls without reducing the rivet diameters. This would give thicker sprocket teeth and a chain with the same wearing qualities.

We would like suggestions from any interested parties regarding thick and thin rolls. It should be remembered that the rolls and bushings must be hardened. If too thin would they not spring in hardening and increase the cost of manufacture?

We trust the ideal proportions for roller chains may soon be located and adopted unanimously by the automobile manufacturers.

THE WHITNEY MFG. CO.,
Per C. E. WHITNEY.

The Same Humbug.

Editor American Machinist:

Three years ago I was "out of a job" in Cincinnati, O., and answered an advertisement for the position of "reporter" for the "Southern Trade Record." The business of the company was explained to me by the manager. After some days of waiting for the position promised me by the manager, and after losing a good shop job thereby, I called at the office of the paper, as I then had reason to believe that they wanted me to be a party to their business; not on salary, but by the commissions I might make by selling to victims certain copies of the paper, containing their recommendation. I saw at once that the business was a "fake," and no one but a schoolboy would believe that the paper had merit.

Your article at page 36 relates to the same humbug I was up against, and by showing them up you have done what I was going to do three years ago.

"TRAMP."

A Non-Spilling Ink Bottle.

Editor American Machinist:

I am not an agent for any firm manufacturing ink bottles, but would say there is a non-spillable bottle, made in New York, I have been using for the past two years, that can be refilled by using a pencil as a pump plunger. Said bottle will stand, when new, forever upside down, and not a drop will come out. Mine, two years old, will stand quite a while upside down and not leak. Sometimes it goes rolling all over my table, upside down in several places, and not a mark or spot.

A READER.

AMERICAN MACHINIST

Published at 218 William St., New York, every Thursday by the

American Machinist Press.

[INCORPORATED.]

Also published at 34 Norfolk St., Strand, London, W. C.

Correspondence on mechanical subjects solicited. Name and address must always be given—not necessarily for publication.

Address all business communications to the American Machinist Press. Matter for reading columns may be addressed to the Editor.

Subscribers can have address changed at will. Give old and new addresses. Date on wrapper denotes end of month in which subscription expires.

Subscription Price:

$4 per year, postage prepaid, to any post office in North America, $5 in all foreign countries except Europe; Twenty-five Shillings there. No back numbers beyond current year. For sale by newsdealers generally.

European subscriptions served by the AMERICAN MACHINIST CO., LTD., 34 Norfolk St., Strand, London, W. C.

Entered at New York P. O. as mail matter of the second class.

Cable address. "MACHINIST," N. Y.
Lieber's and A B C Codes.

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The Abatement of Smoke.

We have previously commented upon the fact that it is designed to make the coming St. Louis Exhibition an example of smokelessness; that all combustion of fuel that goes on there is to be as nearly smokeless as possible, and that special pains are to be taken to enable those who may be interested to see just how and by what special arrangements or appliances the smokelessness is secured. We expect the exhibition to accomplish much good in this way, but in the meantime need our smoke-accursed manufacturing cities wait longer before inaugurating measures looking to the abatement of smoke? We think not. On the contrary, we think that the authorities of Pittsburgh, Cincinnati, Chicago, St. Louis and other smoke-blanketed cities, small and large, ought to do something about this now, and we further believe that, no matter how many unsuccessful attempts may have been made before, it is possible to do very much if the attempt is made in the right way.

Cleveland has been for years one of the smokiest cities in the country. Many abortive attempts had been made to improve conditions there and to let God's sunshine reach its streets and buildings with somewhat less obstruction and difficulty. There was in fact at least as much reason for despair and for believing that no improvement could be brought about as could be found at the present time in any other city in the country. Nevertheless, in 1900 another attempt was made to clear Cleveland's atmosphere. It is still being kept up, with a very gratifying degree of success, and the man who has done this work, Prof. C. H. Benjamin, of the Case School of Applied Science, tells us in another column how it has been done. His story is well told and ought to be of the greatest possible interest to every dweller in smoke. It points the way to better conditions of living, and makes it clear, first, that the real interest of the owner of a smoke-producing chimney is to make it smokeless; second, that he can usually be convinced of this fact and induced to make the necessary provision for smokeless combustion; and, third, that the time has now come when it is the right of a community to insist, if necessary, that its air which its people must breathe, and which surrounds every object they come in contact with, shall not be unnecessarily thickened and polluted by coal smoke.

Prof. Benjamin's statement that experience in Cleveland, careful and expert tests, have shown a saving in coal bills ranging from 15 to 25 per cent. as a result of smokeless combustion, is not to be dismissed as the claim of a stoker salesman; it is the careful statement of a careful, unbiased and thoroughly well informed man, and constitutes probably the most encouraging feature of the situation. A smoke producer may resist appeals to his civic pride, to his altruistic or other finer feelings; but when he can be confronted with indubitable proofs that he will save money by making less smoke he may be expected to listen.

Not only is this saving due to smokeless combustion the most encouraging feature of the situation, but it is a recent demonstration and hence supplies a motive for the use of smokeless furnaces which has heretofore had no existence. It is not so long ago that chemists collected samples of smoke and determined, by weighing, the amount of carbon contained. This was found to be an insignificant percentage of the coal burned and the dictum went forth that there could be no gain in economy by smokeless combustion. Worse than this, the great excess of air introduced by some forms of smokeless furnaces was held by some to be necessary for smokeless combustion, and it was even believed that because of this excess smokeless combustion was accompanied by positive loss.

This is now known to have been a very insufficient examination of the subject. The actual weight of the carbon in smoke is as small as ever, but it is now known that the production of smoke is an indication that large waste is going on due to the half burning of a considerable proportion of the carbon of the coal to invisible carbon monoxide instead of completely burning it to the dioxide. In addition to this, the fouling of the flues by the deposit of smoke leads to a considerable loss in the efficiency of the boiler. Why it should have taken so long to learn the real facts we do not know, but it is extremely fortunate that it has at last been demonstrated that the prevention of smoke is a measure of considerable economy, for that, no doubt, will do more to promote improvement than all other influences combined.

Executors of the estate of Ephraim W. Mentzer, of Hollidaysburg, Pa., are reported to have entered suit against the Pennsylvania Railroad Company, to recover the sum of $768,958 as damages resulting to Mr. Mentzer on account of secret rebates and drawbacks given to his competitors in the coal business between the years 1880 and 1899. If such rebates and drawbacks were given it is to be hoped that the estate will recover the full amount and that such suits will become much more the fashion than they have been.

A press despatch announces that Walter Miller Potts, who is described as engineer of the Poutiloff Works Company, of St. Petersburg, Russia, is in Milwaukee negotiating for some patent rights owned by the Allis-Chalmers Company and the Bucyrus Company, of South Milwaukee, with a view to manufacturing certain lines of machinery in Russia. We do not know whether we are indebted to Mr. Potts or to the press agent for the humorous

features of the report, but Mr. Potts is credited with saying that the expectation is to make this machinery in Russia considerably cheaper than it is made here in America, and for example he says the shovels of the excavators are made here in sections which are riveted together, whereas in Russia they expect to stamp them out. If one had no knowledge of such affairs he might suppose that the art of stamping things out had been highly developed in Russia and was unknown in America, though of course that is very far from the actual fact, and to one who has been in Russia the idea that machinery can be manufactured there considerably cheaper than it can be made in America is rather decidedly amusing.

It is reported that the town of Bucyrus, Ohio, issued bonds to the amount of $50,000 some time ago to buy a factory and that local parties in interest having sued out an injunction the town has confessed bankruptcy and has applied for a receiver, which we suppose is a way of arriving at a settlement of the difficulty.

The United States Government proposes to establish at Sandy Hook a school to instruct West Point graduates detailed for the inspection of arms in the mechanical working of heavy fire arms. Capt. Dunn, from the arsenal near Philadelphia, has been detailed by the Ordnance Department to make a tour of all the colleges and universities where mechanical engineering is taught with a view of collecting data.

A fresh outbreak of the difficulty between the Allis-Chalmers Company and the striking machinists seems to have taken place as a result of the importation of some additional men from the East to take the place of strikers. It is reported that picketing has been renewed and that new vigor has been put into the fight. It would seem as though here would be a good opportunity for the recently appointed committee of the National Civic Federation.

For a Naval Engineering Experimental Station.

Senator Hale, chairman of the Committee on Naval Affairs, has introduced a bill in Congress appropriating the sum of $200,000 to be immediately available, to be used in the erection and equipment of buildings for a naval engineering experiment station at the Naval Academy at Annapolis. The bill contains a proviso to the effect that the total cost of said buildings and equipment shall not exceed $400,000.

This subject is one that should receive the prompt endorsement of Congress. The primary necessity and reason for conducting experiments and tests is the increased efficiency of the naval service. A secondary and probably equally important reason for the establishment of the station at the Naval Academy lies in the fact that the laboratory can be made available for the purpose of instructing the cadets. As a post-graduate course of engineering will undoubtedly soon be established at the Naval Academy, there will be justification for an experimental station at the institution for this purpose alone.

Regarding the need for an engineering experiment station, Rear Admiral Melville, chief of the Bureau of Steam Engineering, recently said:

The leading marine engine builders, consulting engineers and talented professors of various technological schools have repeatedly urged me to impress upon the Navy Department and Congress the necessity for such a laboratory. It can hardly be expected that individual shipbuilders and the scientific colleges should be subjected to the expense of conducting tests that are primarily for the benefit of the naval service.

The following are some of the problems that the the navy should at least assist in solving:

The best means of utilizing liquid fuel for naval and maritime uses: A new impetus has been given the consideration of this subject by reason of the discovery of the Texas and California crude-oil fields.

The value of the steam turbine for naval purposes: The British Admiralty regards this subject as of vital importance, and the success achieved with the two torpedo-boat destroyers installed with this appliance warrants increased attention being given to the matter.

The value of electricity as a prime mover for naval purposes: In the United States Navy the use of electricity is more extended than in that of any other service. Its endurance for naval purposes has been seriously questioned by others. Systematic tests and experiments would undoubtedly prove exceedingly beneficial.

The corrosion of boiler and condenser tubes: The rapid deterioration of both boiler and condenser tubes seriously decreases the engineering efficiency of the modern warship. The bureau has made some important tests in connection with this matter, but the necessity for further investigation and experiment is exceedingly apparent.

The best form and type of water-tube boilers for naval purposes: There are military and tactical reasons why our navy should soon settle upon an approved type of boiler. There are so many factors that will interfere with boiler efficiency that extended experiments are necessary to secure valuable information upon the subject.

The possible advantages resulting from extended use of compressed air as a motor: Particularly at navy yards, and even upon repairs to ships in commission, the extended use of compressed air could be advantageously employed.

The balancing of marine engines: There is a progressive tendency to increased piston speeds, and with each succeeding year the necessity for more perfect balancing becomes necessary.

The development of the storage battery for marine purposes: The discovery of a storage battery of decreased weight, but increased endurance will greatly advance the use of electric motors in the service.

The perfection of a more reliable and efficient gas engine.

Extended investigation as to the best forms of steam, hydraulic and pneumatic joints.

In the solution of these important problems the matter of expert talent is very important in connecting tests. It can never be doubted but that a capable and strong force of engineer officers will always be stationed at the Naval Academy, and therefore there will always be available highly trained officers for conducting experiments if the engineering laboratory is established at Annapolis.

With an established experimental station equipped not only with the best but exceedingly complete appliances, important tests and experiments could be carried on continuously and efficiently, and not in the interrupted and desultory way in which most experiments have heretofore been made. The value and importance of such a station would be greatly appreciated by mechanics and inventors who have not the financial ability to perfect and test their patented appliances. Given such an institution and its facilities the inventive genius and professional aspirations of officers and men of the naval service would be encouraged and expanded.

In conclusion, Admiral Melville says that with such an experimental station the work of training an engineering reserve for the future will be greatly promoted, and if such a building, properly equipped, is established at the Naval Academy it will advance the status of engineering in the navy. TENNILLE.

In our notice of a pamphlet by Prof. H. W. Hibbard on the subject of technical journals and indexing we inadvertently omitted his address, and have had several inquiries for it. It is, care of Cornell University, Ithaca, N. Y.

Personal.

Daniel Ashworth, Pittsburgh, Pa., has accepted the position of sales manager for the Pittsburgh district for the C. W. Hunt Company, West New Brighton, N. Y.

Obituary.

Christopher Zug, a pioneer iron manufacturer of Western Pennsylvania, died in Pittsburgh, January 13, ninety-five years old.

Charles Pemberton Deane, founder of the Deane Pump Works, died at Springfield, Mass., January 9, fifty-six years old. Mr. Deane invented his first

pump soon after graduating from Brown University and soon became engaged in its manufacture. The headquarters of the business were first at Ludlow, but the works have been for many years at Holyoke. The business was absorbed by the International Pump Company, with which Mr. Deane was associated in recent years.

Thomas Wrigley, for more than forty years a builder of silk machinery, died at Paterson, N. J., January 8, seventy-seven years old. Mr. Wrigley came to this country from England at an early age and learned the machinist trade at the Rogers Locomotive Works. In 1848 he went into business with his brother. After several changes he became sole proprietor in 1865, the business growing to one of considerable proportions and turning out a variety of ingenious and valuable machinery for silk manufacture.

A Historic Locomotive.

Purdue's second historic locomotive has reached the University. It is deposited with the University by the Baltimore & Ohio Railroad as a result of interest shown by Mr. J. N. Barr and Mr. F. D. Underwood, when with the Baltimore & Ohio Railroad, and Mr. F. D. Casanave, the present general superintendent of motive power. The engine belongs to what is known as the "camel-back" type and is designated by the initials "B. and O., No. 173." This type of locomotive was originated some forty years ago by Mr. Ross Winans, one of the most eminent of the early locomotive designers and builders.

Engine No. 173 is of the ten-wheel type and has cylinders 19x22 inches, driving wheels 50 inches in diameter, weight on drivers 56,500 pounds and a total weight of 77,100 pounds. The shell of its boiler is 48 inches in diameter. It was built in 1868 and is therefore thirty-three years old. It has been in regular service until withdrawn to be put in order for delivery to the University, after which it made the trip from Baltimore to Lafayette under its own steam in six days.

This engine of thirty odd years ago presents many interesting features, the whole machine being in fact designed with wonderful skill and ingenuity. The name "camel-back," as may be surmised, was given to the engine on account of the peculiar appearance produced by the large cab on the central part of the barrel, and of the rapidly receding back end, with its staircase and hand rail on the steeply inclined firebox, all of which gave the engine a humped appearance.

It is said that the chief aim of Mr. Winans was to produce a locomotive having a maximum capacity at a minimum cost, and this he apparently succeeded in accomplishing, for it is proverbial that the Winans engines did a larger amount of work than any other type used at that time and the business of making them resulted in a large fortune to Mr. Winans. The Purdue "camel-back" is different from the original Winans engine, which had eight driving wheels and no truck. The Purdue engine also has a Stephenson link motion and injectors, while the original engines used the hook motion and pumps. The driving tires of the Purdue engine are secured by gibs in addition to shrinkage. The driving springs are used as equalizers and are not placed central over the axles.

It is of interest to note also that the firebox of Purdue's "camel-back" extends entirely back of the rear axle, giving an opportunity to make it wider than those boxes which were placed between the frames, after the manner which was common when Mr. Winans lived. It is noteworthy also that the wide firebox with an inclined top is now again coming into use, being found in the best of recent designs.

Commercial Review.

NEW YORK, Monday, Jan. 20.

MACHINE-TOOL MARKET AND OTHER NOTES.

The month so far has been marked by the fruition of important purchases of machine tools by two Eastern railroads. The Baltimore & Ohio has just closed an amount footing up to between $50,000 and $100,000. The tools will, it is said, be installed at various points on the road, a considerable proportion going to the Mount Clare (Baltimore) shops. The Lehigh Valley Railroad has also, during the month closed for a quantity of tools footing up beyond $50,000. Both of these orders were divided, but the Niles-Bement-Pond Company received the greater part in each case. Among other companies securing part of the Lehigh Valley order was the Garvin Machine Company.

Beside purchasing machine tools the Lehigh Valley Railroad Company has ordered seven 500-foot air compressors from the Chicago Pneumatic Tool Company. The latter company is now devoting special attention to its New York and Franklin air-compressor branches and reports the outlook very encouraging.

Locomotive building still demands notice in a review of the market and just now it comes up in connection with some large crane work. The American Locomotive Company—which, by the way, proposes to expend a couple of million in improvements this year—is putting up a large erecting shop—the building of which is to cost $100,000—at the Richmond, Va., plant. A contract has just been let for a 120-ton, two-trolley 6-motor and a 30-ton 4-motor Niles traveling crane. The Rogers Locomotive Works, Paterson, N. J., which has given out contracts for the erection of a new boiler shop, will install cranes large enough to lift a complete locomotive. The Rogers Locomotive Company, Paterson, N. J., in spite of the short time that has elapsed since it took hold of the old works has orders enough to keep the plant busy until next November, and expects shortly to have 2,500 men men at work. Returning to the American Locomotive Company, among its plans is the enlargement of its Pittsburgh works. As the plant is crowded with work, an enlargement would be welcome.

The Hicks Locomotive Works at Chicago Heights have awarded a contract for the erection of a two-story addition 200x250 feet. It will accommodate eleven standard tracks and give room for the manufacture of twenty-five coaches at the same time.

As indicated in our last report, a difficulty is being met with by some manufacturers in securing an adequate supply of castings—at least in the larger sizes. An oversold material market also proves a hindrance to business, as where a prospective purchaser of machine tools lately told a dealer that it would be useless to buy the tools when he couldn't get the material to work with them.

A circumstance which has attracted attention before in the last few months has just received a fresh illustration, viz., that prices are advanced in the West and cut in the East. Recently a Western builder of shapers has stiffened up the price, while an Eastern builder of the same has made concessions. It is true that the difference in neither case was large. It would not be fair to judge conditions in these two sections of the country from the circumstances noted, although it is evident enough that the area of business high pressure is tending to travel westward. Trade activity in New England, as elsewhere, is super-normal, although there are exceptions to it. Such an exception is found in the case of a company which manufactures a special machine tool of high grade and which is reported to be quite slack on its own work, although it is taking in some from another company which has a better run of orders.

The rush in Pittsburgh steel mills is such that some are working Sundays which never did before. One concern in booking an order for 1,000 tons at the maximum price requested the purchaser to make the order as small as he conveniently could. It is claimed that higher prices could readily be obtained were it not the policy of the mills to keep them down. For instance, it is asserted that Bessemer pig, which is now selling at $16.75, would fetch $20.00.

Jones & Laughlins, Ltd., have just broken their record by turning out 2,600 tons of steel product in one day. Their output of pig iron is of course not included.

It is somewhat unusual to import large machinery into the United States, but the Chrome Steel Works, of Brooklyn, have been negotiating and we understand have practically closed an order in Germany for a large hydraulic forging equipment for installation in an extension to their plant at Carteret, N. J. The machine will weigh, it is said, 380 tons—the cylinder alone 50

tons—and exert a pressure of 3,500 tons, and will be subjected to an import duty of 45 per cent.

The contract for the electrical plant of the St. Louis World's Fair is just about being opened for bids.

Advertisements are prominently appearing in the daily press of the Automatic Weighing Machine Company, which has acquired the weighing-machine interests of the Pratt & Whitney Company, Hartford, Conn., and the New England Automatic Weighing Machine Company, Boston, and desires to secure additional capital to increase its plant and extend its business. The company's headquarters are at 275 Congress street, Boston. P. Lorillard, Jr., is president; Walter L. Clark, of the Niles-Bement-Pond Company, is vice-president, and Robert C. McKinney, president of the Niles-Bement-Pond Company, is one of the directors.

CHICAGO MACHINERY MARKET.

One seller of machine tools in the West, while reviewing trade during the past month, remarked that the week which dipped into both years, or New Year's week, was the best they had had in many months. While estimates concerning trade during the past month vary not a little, the word that comes from the factories is that they are running full and some of them dropping behind in their orders. Large shapers are difficult to procure and both dealers and users are ordering in advance of their wants.

The slump in copper may have nothing to do with it, but there is said to be a good market for machinery in the Lake copper districts just now. Possibly shutdowns and repairs are anticipated. There is a quickening of inquiry from automobile builders also. When this industry was announced several years ago as the probable successor of the bicycle there was a fair buying of machinery. But the first vehicles turned out—electrical affairs—did not prove a glowing success and the industry from a machinery point languished. Recently the production of gas or steam-propelled vehicles seems to have a start and there is again a better inquiry from machine-tool users, who are very much in evidence just now. The railroads are continually taking a fair amount of shop equipment and the number of repair shops that are springing up throughout the growing West is considerable. All this and much more makes a steady trade for the tool builders, which this year they are receiving in the usually dull month of January.

Pawling & Harnischfeger, Milwaukee, have obtained from the Allis-Chalmers Company an order for twenty-five electric cranes, the value amounting to about $125,000. This is one of the largest crane orders ever placed in the West. The Holthoff Machinery Company, Milwaukee, have bought machine tools to the value of about $35,000 from the Niles Tool Works, Hill, Clarke & Co. and others for the manufacture of mining machinery. The E. P. Holden Machinery Company, Chicago, have been good buyers of machine tools lately and report a brisk demand for their present product. The Chicago office of the Pratt & Whitney Company did more business during the first fifteen days of January than the entire month of January last year.

The Niles Tool Works are running full and maintaining a satisfactory trade. The only difficulty they are now experiencing is a scarcity of good machinists. In no better way, perhaps, can the difference of conditions between this country and Germany be illustrated. There, many good machinists are idle; here, they are not equal to the present industrial needs.

Quotations.

NEW YORK, Monday, Jan. 20.

Pennsylvania Foundry Pig Iron, Jersey City delivery:

No. 1 X	$17 15 @ $17 65
No. 2 X	16 65 @ 17 15
No. 2 plain	16 15 @ 16 65
Gray forge	15 25 @ 15 75

Alabama Pig, New York delivery:

No. 1 foundry, or soft	16 25 @ 16 50
No. 2 foundry, or soft	15 75 @ 16 00
No. 3 foundry	15 25 @ 15 50
Foundry forge, or No. 4	14 75 @ 15 00

Bar Iron—Base sizes—Refined brands, mill price on dock, 1.68c. in carload lots. For smaller quantities from store some are willing to quote as low as 1.90c., but 1.95c. is stated to be the general price.

Tool Steel—Base sizes—Good standard quality, 7c.; extra grades, 10c. and upward.

Machinery Steel—Base sizes—1.95 @ 2.00c. from store.

Cold Rolled Steel Shafting—Base sizes—From store, 2¼ @ 2½c.

Copper—Lake ingot, 11 @ 11⅛c.; electrolytic, 10⅞ @ 11c.; casting, 10¾ @ 10⅞c.

Pig Tin—In 5- and 10-ton lots, f. o. b., New York, 24 @ 24¼c.

Pig Lead—For wholesale lots, 4c., with .02½ @ .05c. extra for carloads.

Spelter—4.30 @ 4.35c. for ordinary quality, New York delivery.

Antimony—Cookson's, 10⅛ @ 10⅜c.; Hallett's, 8⅛c.; U. S., 8¼ @ 8½c.; Italian, 7¾ @ 7⅞c.

Lard Oil—Prime City, 80 @ 81c. in wholesale lots.

New Corporations.

Dietrich Gear Co., of New York; capital, $50,000.

Spaulding Automobile & Motor Co., of Buffalo, N. Y.; capital, $80,000.

Columbus Motor Vehicle Co., of Columbus, O. (capital, $50,000), has filed a certificate of incorporation in Delaware.

Bryant Manufacturing Co.; object, to deal in iron and steel; capital, $1,000,000. Incorporators: Howard M. Carter, Evanston, Ill., and others.

Marine Boiler Works Co.; principal office, 419 Market street, Camden, N. J.; capital, $100,000. Incorporators: C. A. Leeper, Richard Reeves, C. B. Floyd.

Hunt Foundry & Machine Co.; principal office, 419 Market street, Camden, N. J.; capital, $100,000. Incorporators: H. E. Hunt, Geo. H. Clapp, M. J. Dair.

The International Marine Governor Company, capital $1,000,000, has filed articles of incorporation. The incorporators are residents of Mount Holly, N. J.

National Abrasive Manufacturing Co., of New York city; object, to develop mines and acquire mining rights in North Carolina and elsewhere; capital, $1,500,000.

Grant-Williams-Barker Co., Pine street, Rahway, N. J.; object, manufacturing steel, iron, etc.; capital, $200,000. Incorporators: Robert Grant, Frank E. Williams and Alfred K. Barker.

Automatic Clerk Co., 101 Lafayette street, Newark, N. J.; object, manufacturing automatic machines; capital, $1,000,000. Incorporators: Isaac R. Mansfield, Geo. W. Feltham and Geo. W. Renn.

Lanser Filter Manufacturing Co., 419 Market street, Camden, N. J.; object, manufacturing filters, etc.; capital, $100,000. Incorporators: Nicholas Lanser, J. H. Friedman, John Swan, Jr., and John C. Ingham.

American Foundry Co.; Corporation Trust Co., 15 Exchange place, Jersey City, N. J.; object, manufacturing railroad appliances; capital, $120,000. Incorporators: H. S. Gould, Evan J. Dudley and K. K. McLaren.

Golden Gate Steel & Iron Co.; Corporation Trust Co., 15 Exchange place, Jersey City, N. J.; object, manufacturing iron, steel, etc.; capital, $125,000. Incorporators: Robert L. Smith, Edw. C. McDowell and K. K. McLaren.

Pneumatic Textile Machinery Co.; Corporation Trust Co., 15 Exchange place, Jersey City, N. J.; object, manufacturing textile machinery, etc.; capital, $10,000. Incorporators: H. S. Gould, John I. Billings, K. K. McLaren.

National Nut Co.; principal office, corporation Trust Co., 15 Exchange place, Jersey City, N. J.; object, manufacturing metallic compounds, etc.; capital, $50,000. Incorporators: Geo. D. Dutton, Frank W. Dutton and K. K. McLaren.

Norman Cordage & Machine Co.; Corporation Trust Co., 15 Exchange place, Jersey City, N. J.; object, manufacturing cordage machinery, etc.; capital, $500,000. Incorporators: Thos. W. Norman, Harry W. Hildreth and Richard Delaney.

United States Light & Heating Co. (capital, $3,000,000) has filed a certificate of incorporation in New Jersey. The company is to furnish electricity, light and heat, especially for railways and railway cars. The incorporators are Wm. B. Irwin, Wallace Young, John J. Gilbert, all of Jersey City.

The United States Wireless Message Co. (capital, $100,000) has been incorporated for the wireless transmission of messages and the manufacture of apparatus for the same. The incorporators are Charles Schloemann, Ludwig Bohm, Charles King, W. M. Greene, all of Jersey City. The principal office is at 15 Exchange place, Jersey City, N. J.

New Catalogs.

Naylor Bros., manufacturers of pulleys, hangers, shafting, etc., Peekskill, N. Y., send us copies of their hanger and pulley lists (9½x6¼ inches in size). They are also getting out a larger catalog.

The Warner & Swasey Company, Cleveland, O., has gotten out a 1902 edition of the pamphlet describing its hollow hexagon turret lathe. The catalog is attractively gotten up and is 6x9 inches, standard size.

The Aurora (Ind.) Tool Works has sent us a catalog (6x9 inches, standard size) showing different sizes and varieties of its upright drills, also a radial drill and three-spindle drill. The company is, moreover, introducing a new No. 2 plain milling machine.

We have received a 1901-1902 catalog of the University of Vermont and State Agricultural College, Burlington, Vt. This institution affords courses in civil and sanitary, electrical and mechanical engineering and chemistry, besides the liberal branches. Size of pamphlet, 5¼x6⅝ inches.

"Record of Recent Construction," No. 30, of the Baldwin Locomotive Works, Philadelphia, Pa., consists of an address by S. M. Vauclain to the officers and employees of the Union Pacific Railway. One feature of the pamphlet is a simply constructed working model of a valve. Size of page, 9x6 inches, standard.

We have received a copy of the descriptive catalog of the Peerless belt lacer, manufactured by the Peerless Belt Lacing Machine Company, Swanson and Moore streets, Philadelphia, Pa. It gives illustrations, explanation and prices of the machines, which employ coil lacing for their work. The catalog is 3½x6½ inches.

The Lodge & Shipley Machine Tool Company, Cincinnati, O., has sent us a copy of its Catalog I, which is a handsome publication describing the company's line of engine lathes, which are shown up to 38 inches swing. There are also a 24-inch turret chucking lathe, 24-inch extra heavy screw machine, combination 24-inch turret engine lathe, etc. The catalog is 9x6 inches, standard size.

We acknowledge the receipt of a volume of bulletins (7x10 inches) of the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., in binder; also a number of other pamphlets which have been published by the Westinghouse companies at various times, including: "Steam Turbines," by Francis Hodgkinson: "The Capacity and Rating of Railway Motors," "The Service Capacity of Railway Motors," by Norman Wilson Storer; "Polyphase Transmission," by Charles F. Scott; "The Induction Motor and the Rotary Converter and Their Relation to the Transmission System," by Charles F. Scott; "O. D. Transformers"; "Electric Locomotives for Mine Haulage" (published jointly with the Baldwin Locomotive Works); "Westinghouse Automatic Circuit Breakers"; "Wurts Non-Arcing Lightning Arresters"; "Westinghouse Integrating Wattmeters"; "One Million Horse Power Westinghouse Electrical and Steam Apparatus, New York and Vicinity." Most of these pamphlets are 6x9 inches, standard size.

Manufacturers.

The National Carbon Company, Cleveland, O., will erect an addition.

A. J. White & Son's planing mill in Newport, Vt., has been burned.

A foundry will probably be built in McComb, O., by Duncan & Nusbaum.

A power-house is to be built in Lansing, Mich., by the Hawks-Angus syndicate.

The Frontier Mineral Paint Company, Detroit, Mich., has plans for a new plant.

The Atlas engine works, Indianapolis, Ind., will build a cupola-house, to cost $6,000.

The A., H. & G. R. R., Hallowell, Me., is building or reconstructing a power-house.

The Northwestern Malleable Iron Company, Milwaukee, Wis., is about to build an annealing house.

The Hauser, Brenner & Fath Cooperage Company, Cincinnati, O., is about to build a new plant.

Abraham Williams, Nazareth, Pa., is building a factory to manufacture bags for shipping cement.

The Colt Patent Fire Arms Company, Hartford, Conn., is preparing to increase its manufacturing facilities.

The Rochester & Eastern Railroad has found a suitable site for its car shops in Canandaigua, N. Y.

An extensive plant is to be built in the Menomonee Valley by the Milwaukee (Wis.) Gas Light Company.

A fire at the factory of the Waltham Emery Wheel Company, Waltham, Mass., recently did considerable damage.

The Chicago & Cleveland Car Roofing Company is about to build a 100x325-foot factory in Cleveland, O.

The Northwestern Knitting Works, Minneapolis, Minn., have applied for a permit to build a factory addition.

The plant of the South Zanesville (O.) Sewer Pipe & Brick Company has been burned. It will be rebuilt at once.

The St. Louis (Mo.) & Belleville (Ill.) Electric Railway Company will build an addition to its power-house.

A two-story building is to be erected at 76 Illinois street, Buffalo, N. Y., by the Queen City Engineering Company.

A. W. Cadman, Pittsburgh, Pa., has been granted a permit for a brick foundry and machine shop on Smallman street.

Hammonton, N. J., will vote January 29 on the question of issuing $30,000 bonds to construct a municipal water plant.

The Stanley Works, hardware, New Britain, Conn., has awarded the contract for the brick work on its new rolling mill.

The Hart & Cooley Company, manufacturer of air furnaces, New Britain, Conn., will build a frame addition to its plant.

The Arantz Brothers Lumber Company, New Decatur, Ala., is making preparations to add a fine veneering plant to its mill.

The Haverhill Box Board Company is about to build a plant in Haverhill, Mass. The main building will be 200x533 feet.

Ground has been broken near Canonsburg, Pa., for the buildings for the Simpson Stove & Manufacturing Company, of Pittsburgh.

Work on a new P. & F. Corbin factory, New Britain, Conn., has been begun. The building will be 200x60 feet, seven stories.

George W. Arnett, Lambertville, N. J., has a contract to build a plant there for a hairpin and wire novelty manufacturing company.

The S., M. & O. V. Traction Company proposes to build a new power-house and car barns, and Brilliant, O., may secure them.

It is reported at Raleigh, N. C., that the chief shops of the Seaboard Air Line will be rebuilt and may be at Raleigh and Savannah.

It is said that the Chicago, Milwaukee & St. Paul Railway Company will erect an addition to its shops in Dubuque, Ia., next summer.

The American Bridge Company is preparing to begin the construction of its long-planned new plant in the vicinity of Homestead, Pa.

Contracts have been awarded for the erection of an addition to the power-house of the Fair Haven & Westville (Conn.) Street Railway Company.

The Atlas Tack Company is having built in Fairhaven, Mass., a new mill, about 700x220 feet, into which it will move its Taunton shops about May 1.

The West Virginia Pulp & Paper Company has commenced the brick work on the several buildings which it will add to its plant at Luke, Md., this year.

The Southern Pacific Railway is to build shops at Los Angeles, Cal., at an expenditure of $300,000 to $400,000, and work will begin on the buildings at once.

The Federal Chemical Company, Louisville, Ky., will build a plant in West Nashville, Tenn., having an annual capacity of 75,000 tons of finished fertilizer.

Geo. Rush, of New York, has bought land near Beaumont, Tex., for a company which he represents, as a site for a big oil refinery and foundry and machine shops.

The Milwaukee Machine Tool Company is about to build a boiler and engine house at Walnut street, between Thirieth and Thirty-first streets, Milwaukee, Wis.

The Cross Engineering Company, Carbondale, Pa., manufacturer of mining machinery, will fit up a plant which will include a forging department and machine shop.

The Union Mills, of Aldrich Manufacturing Company, Moosup, Conn., are about to double the size of their plant by the addition of a new building and about eighty looms.

A shop, having room for twenty forges, and an office addition will be built at the plant of the Frankford Chain Works, Margaret and Pearce streets, Philadelphia, Pa.

A machine shop and foundry building will be erected for the Lehigh Foundry Company, of Fullerton, Pa. The plans show a building, 460x45 feet, with an extension 285x36 feet.

It is expected that summer will see work on the new shops of the Carbondale Machine Company, Carbondale, Pa., under way; so as to be ready for occupancy on April 1, 1903.

The East Side Lumber Company, of Stillwater, Minn., is making changes and repairs in its sawmill plant at Houlton, Wis., the improvements to cost something over $12,000.

The American Sugar Refining Company, which owns the sugar house in Jersey City, N. J., has decided to extend its work there. The addition will be 100x188 feet, three stories.

The Clark Caster Company, Plainville, Conn., has outgrown its present quarters and finds it necessary to build. The factory will be erected on land where there is an excellent water privilege.

The Hampden Corundrum Wheel Company has increased its capital stock and will make additions to its plant in Brightwood, Mass. The company has purchased an emery mine at Peekskill, N. Y.

The West Michigan Machine Works, composed of William Boerma and Charles E. Richmond, will soon start on Canal street, Grand Rapids, Mich., and will manufacture wood-working tools.

Seng Manufacturing Company, Chicago, Ill., manufacturer of furniture fixtures, has applied for a permit to build a three-story brick factory at 47-51 Dayton street, at an estimated cost of $20,000.

The St. Clair Steel Company has purchased a tract of land adjoining Glassport, Pa., aggregating about 25 acres along the river front. It is rumored that the company proposes to erect a new steel mill.

Report has it that C. A. Lux, of Clyde, N. Y., some time ago secured options on property and waterpower at and above the Salmon River Falls, and that it is proposed to develop the water power electrically.

The contract has been let for construction of a new plant for the Alabama Iron Works, Mobile, Ala. The most improved machinery will be installed. There will be an overhead traveling crane of 50 tons' capacity.

Contracts for the structural steel for a factory building to be erected by the Boston

Wharf Company at Summer and Melcher streets, South Boston, Mass., have been awarded to the Carnegie Steel Company.

The contract for building the electric light plant at Wellington, Kan., has been awarded to A. M. Patitz, of Milwaukee, Wis. There is to be a capacity of 75 arc lights, at least 1,500 incandescent lights and motive power.

Davis, Kelly & Co., of Louisville, Ky., are behind the movement to organize the Louisville Steel & Iron Company, capitalized at $500,000. It is planned to erect a plant for the manufacture of sheets and other steel products.

Leavenworth, Kan., will have a packing house, known as the Leavenworth Packing Company. The capital stock will be $100,000. August Thudium is one of the largest stockholders and probably will manage the new plant.

Ground has been broken at Leominster Park for a 30x40-foot boiler-house and blacksmith shop for the Worcester (Mass.) Consolidated Street Railway Company. The house is to be equipped with a 40 horse-power engine to heat the car barn.

Fred. and William Boyer and ex-Sheriff Frank H. Schmeck, all of Reading, Pa., have purchased a farm at Evansville and will erect a cement works. A company, incorporated in Trenton, with a capital of $100,000, will operate the plant.

A new company has been organized by some Toronto, Ont., capitalists, to be called the Imperial Bag Company, Limited. The capital is $150,000, and fully $75,000 will be spent in land, plant and buildings. Jute and cotton bags will be made.

A million-bushel elevator for Wichita, Kan., is almost in sight. A company is being formed. The Wichita Chamber of Commerce is more or less conversant with the enterprise and might be addressed, also the E. K. Neveling Grain Company.

Work has been started on an enlargement of the plant of the Ashcroft Manufacturing Company, maker of steam specialties, Bridgeport, Conn. There will be an addition to the forge shop, 43x60 feet; an extension of the brass foundry, 43x100 feet.

The Bristol Builders' Supply Company, Fair Haven, Mass., intends making additions to its plant soon. A new engine and boiler will be installed. A window frame machine is to be put in at once, and the company thinks also of putting in a mortiser.

The American Windmill & Manufacturing Company, Kansas City, Mo., has been granted a permit to erect a frame factory, to cost $2,000. Next summer a new building, to cost $5,000, will be erected to supersede it. The present quarters of the company are at 411 Southwest boulevard.

Follansbee Brothers, of Second avenue, Pittsburgh, Pa., have secured options on a large acreage on the Ohio River, in West Virginia, opposite Steubenville. Engineer Edward E. Erikson, is engaged in drawing plans for an eight-mill tin plate plant, to cost in the neighborhood of $400,000.

The Mason (Mich.) Sugar Company has been incorporated with $300,000 capital. L. C. Webb was elected president, W. M. McCrossen, vice-president; C. P. Mickelson, secretary, and H. M. Williams, treasurer. Bids to build a 500 or 600-ton beet sugar factory were to be taken January 11.

The Pennsylvania Railroad Company will, within the next few months, expend half a million dollars in the enlargement of its shops and improvement of its property at Fort Wayne, Ind. A new coal yard will be provided and will be equipped with modern machinery for loading and unloading coal. The machine shop will be extended.

The Fombell Clay Manufacturing Company has been incorporated in New Jersey and will build a plant near Fombell, Beaver County, Pa. The incorporators are W. G. Clark, of Beaver County; A. G. C. Rhodes, formerly of the American Tin Plate Company; M. Jacobs and Herbert Carlton. The formal "head office" is 419 Market street, Camden, N. J.

The Kellogg Iron Works, of Buffalo, N. Y., have been given a contract to erect 900 tons of steel frames for the American Locomotive Company at the Brooks plant in Dunkirk. This contract includes the hammer shop, machine shop, paint shop and some other structures. It is estimated that the new buildings will cost in the neighborhood of $425,000.

A company of New York and Philadelphia capitalists have organized for the manufacture of white lead and propose to locate in Chester, Pa., giving employment to between 300 and 400 hands. Mr. Lynch, who has been connected with the United Lead Corporation, Bridgewater, Delaware County, Pa., will superintend the erection of the new plant.

W. C. Whitehead, of the Alliance (O.) Machine Company, says that it is the intention of his company to erect a temporary machine shop as soon as possible in order to begin work on contracts already taken. Contracts for the big steel buildings of the permanent plant have already been let, but it will be some time before they can be erected.

Work on a new ten-mill tinplate plant of the McKeesport Manufacturing Company in Port Vue, near McKeesport, Pa., will be started within a few weeks. Samuel Diescher & Sons, of Pittsburgh, have been employed to superintend the construction. J. E. Lauck, of McKeesport, will be superintendent, and E. R. Crawford, of McKeesport, general manager.

Contracts are about being awarded by the Union Steel Company for the construction of two blast furnaces, a group of open-hearth furnaces and steel structural work, at Donora, on the Monongahela River, 20 miles from Pittsburgh, Pa. It is said that the capital invested will be more than $14,000,000 and that the Mellons and H. C. Frick are heavily interested.

The Akron Salt Company, which was incorporated for $200,000 not long ago by Probate Judge G. M. Anderson and Auditor L. E. Sisler, Akron, O.; Auditor A. B. Peckinpaugh, of Wayne County; E. A. Bowen, of Canton, and J. S. Floyd, of Wadsworth, who will be general superintendent, expects to build a 2,000-barrel-a-day plant near Barberton in the spring.

The Marquette cement mills of Deer Park, Ill., have been sold to John Cummings, of La Salle. Back of Mr. Cummings is James Herron Eckles, president of the Commercial National Bank of Chicago, and N. W. Duncan and John Stuart, of the La Salle State Bank. Mr. Eckles states improvements and additions to the plant entailing an expense of $200,000 will be made at once. T. G. Dickinson, of Chicago, will manage the plant.

A new Buffalo manufacturing company has been organized with a capital stock of $100,000. It is the Carwheel Truing Brake Shoe Company. The company will manufacture a shoe made of iron and carborundum, and used for the purpose of truing flat car wheels. J. Black Perry, of Toronto, is president of the company, and Walter D. Ingham, of Buffalo, is secretary. The company intends to build a plant in Buffalo, N. Y.

The Champion Rivet Company, of Cleveland, O., has purchased nine acres at Parnassus, Pa., and will erect a plant at a cost of about $300,000, and eventually its entire works will be moved to that place. Gas will be the fuel used, and the plant will be operated by electricity. It is rumored that the United States Steel Corporation is back of the concern, and that there is now a scheme pending for the consolidation of all rivet-making plants, to be run as an adjunct of the big steel corporation.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Gear Wheels, gear cutting. Grant; see p. 18.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Punches & dies. Wal.M.Wks., Waltham, Mass.

Fine machine and experimental work. The Des Jardins Type Justifier Co., Hartford, Ct.

Wanted—Copy of "American Machinist" of May 14, 1896. Address W. W. M., care A. M.

F. J. Stokes Machine Co., 13th and Noble sts., Philadelphia, Pa., build light machinery.

Light and fine mach'y to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Wanted—Old style screw planer, not less than 42 inches wide. The Highland Machine Co., Boston, Mass.

Will pay 25c. per copy for issues January 26 and February 16, 1899. Address Box 78, AMERICAN MACHINIST.

Special tools, models, fine light mach'y and foundry work wanted. Murray Mfg. Co., Richmond Valley, Staten Island, N. Y.

Wanted—Small machine for graduating cylindrical spindles; second hand preferred. "Capacity," care AMERICAN MACHINIST.

Wanted—Partner who understands construction of gas engines and has some capital. "Hustler," care AMER. MACHINIST.

Wanted—Two second-hand hole and face grinders of the diamond type; two engine lathes, from 12 to 16 in. swing; one 3-16 in. riveting machine. Address Timken Roller Bearing Axle Co., Canton, O.

$25,000.—Promising investment for man with money; fully equipped machine tool plant for sale; advertiser has wide experience, can secure business and produce results, if plant is procured. Address Box 91, AM. M.

Purchaser for small manufacturing plant; lot, 100x180 feet; machine shop, 32x68, two story, with line shaft and gasoline power; foundry, 40x54, new modern equipment; good location; for sale cheap. Hart-Parr Co., Madison, Wis.

Foundry in eastern Pennsylvania, making a specialty of machinery castings, would like to make contract with machinery manufacturing concern for furnishing strictly high-grade castings at lowest figure. Address "Foundry," care AMERICAN MACHINIST.

To Manufacturers of Bolt Cutting Machines and Brass Working Machines—A firm of British toolmakers wish to communicate with above, and will be glad to have catalogs and special terms for exclusive agency. Apply Alfred Herbert, Ltd., Coventry, England.

Institutions retiring from business having machine tools, brass and wood working machinery will find it to their interest to correspond with us. We purchase complete plants or handle them on com. C. C. Wormer Mach. Co., 55-59 Woodbridge st., W., Detroit, Mich.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded; but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents.

Situations Wanted.

Practical mechanical draftsman wishes position. Box 16, AMERICAN MACHINIST.

Situation as general foreman or assistant superintendent; references. Box 83, AM. M.

Competent machine shop or toolroom foreman desires change. Box 76, AMER. MACH.

Mechanical draftsman and designer, competent to manage drawing room. Box 75, AMERICAN MACHINIST.

Practical, systematic machine shop foreman

wants position; splendid references. Box 94, AMERICAN MACHINIST.

A practical superintendent or general machine shop foreman. Address R. J. S., care AMERICAN MACHINIST.

Mechanical draftsman, experienced designer, wishes position near New York city. Box 95, AMERICAN MACHINIST.

Position as foreman; tools, dies, special machinery, drop forging or manufacturing. Address F., care AMERICAN MACHINIST.

Foreman patternmaker desires a change; has new methods; can cut present cost of patterns 25 per cent. Box 86, AMER. MACH.

Designing draftsman, 18 years' experience with leading marine and stationary engine builders, open to responsible position. Box 74, AMERICAN MACHINIST.

A hustling factory superintendent, 37, solicits correspondence; duplicate machines, watch and clock work, punches and dies. Box 85, AMERICAN MACHINIST.

By first-class, practical patternmaker, young man, competent to make drawings and design, to divide time between shop and drawing. Box 90, AMERICAN MACHINIST.

A practical, experienced machine shop foreman wants position where energy and ability are wanted; Middle States preferred. Address Box 81, AMERICAN MACHINIST.

Position as engineer or chief draftsman; technical and practical; 5 years' experience in the above line; 30 years old; best references. Box 79, AMERICAN MACHINIST.

Designer, expert draftsman, wants responsible position; experienced in printing presses, paper bag, metal forming and fine automatic machinery. Box 55, AMERICAN MACHINIST.

Superintendent or foreman, manufacture of electrical machinery and implements, practical, up to date in modern methods; 38 years old; correspondence solicited. Box 77, AM. M.

Expert draftsman and machinist, competent to take an operation from the designing to finish through shop, seeks position; with automobile firm preferred. Box 84, AMER. MACH.

Practical machine designer, technical graduate with shop knowledge, 10 years' experience intricate automatic machinery and tools, light and heavy, wishes to change. Box 51, AMERICAN MACHINIST.

Mechanical draftsman and designer with shop experience wants position; partly outside work preferred, superintending erection of machinery or selling. Address Box 92, AMERICAN MACHINIST.

Graduate of M. I. T., with 7 years' practical experience, now head draftsman cotton manufacturing and printing company, seeks responsible engineering position; refers to present employers. Box 33, AMERICAN MACHINIST.

Young man, age 26, technical graduate, 4 years' experience in cutting down cost of production on turret lathes, milling machines, etc., also as foreman building machine tools, desires change for a future. Box 82, AM. M.

Electrical engineer, inventor and draftsman wants employment for spare hours; electrical apparatus developed and designed for manufacture; motors for direct connection to machine tools a specialty. P. O. Box 205, Brooklyn.

Situation wanted in brass or copper rolling mill, as foreman or assistant foreman, by a young man who has had 8 years' experience in rolling mill work; references from former and present employers; not particular as to location of mill. Address Chas. E. Moore, 1352 Fairfield ave., Bridgeport, Conn.

Mechanical engineer, university graduate, competent designer and draftsman, linguist, shop, business and board experience on steam engines, copper rolling mills, special and automatic machinery, tools, jigs, hydraulic work and electric traveling cranes, seeks change; references and testimonials. Box 93, AM. M.

Mechanical engineer, technical graduate, 14 years' practical experience on automatic and cost-reducing machinery, both as engineer and draftsman, will be open for engagement February 20, 1902; will be pleased to receive proposition as chief engineer or chief draftsman where ability, and not pull, will be appreciated. "Engineer," Box 80, AM. MACH.

Help Wanted.

Machinists; first-class lathe hands; no labor trouble. Bullock Electric Mfg. Co., Cincinnati, O.

Wanted—Tool steel salesman with experience in working steel. Address L. C. D., care AMERICAN MACHINIST.

Wanted—Engineer capable of testing and selling pumping engines; state experience and salary. Box 89, AMERICAN MACHINIST.

Wanted—A mechanical draftsman, experienced in the design of automatic high-speed engines. Box 72, AMERICAN MACHINIST.

Wanted—First-class, all-round machinists on marine work. Call on or address Holland Torpedo Boat Co., New Suffolk, L. I., N. Y.

Machinists wanted, first-class floor men, $2.35 per day, in 9-hour shop, 1 hour from New York. Address Box 57, AMER. MACH.

Draftsman wanted; detail designer and first-class tracer on sawmill and compressed air work. Curtis & Co. Mfg. Co., St. Louis, Mo.

Competent draftsman for machine shop in New York building heavy machinery. Address, with full particulars, A. S., Box 73, AMERICAN MACHINIST.

Wanted—Chicago advertising representative for New York technical weekly; give references and experience. Address H., care AMERICAN MACHINIST.

Wanted—In New York, experienced designing draftsman on automatic machinery; state qualifications and salary expected. Box 88, AMERICAN MACHINIST.

Draftsman wanted; one with experience on tools and fixtures, for manufacturing small parts, preferred. Address "Hydraulic," care AMERICAN MACHINIST.

Wanted—First-class foreman for machine shop; must have first-class references; a Western mechanic preferred. Address Box 60, AMERICAN MACHINIST.

Wanted—Number of patternmakers, experienced on compressor or steam engine work; none others need apply. Franklin Air-Compressor Co., Franklin, Pa.

Foreman brass molder wanted; one thoroughly accustomed to engineers' and plumbing goods; state experience and references. Box 71, AMERICAN MACHINIST.

Wanted—By Struthers, Wells & Co., of Warren, Pa., experienced draftsmen to work on gas engine drawings; write at once for particulars, stating age and experience.

New York city; general machinist on quite heavy machinery; young man; experienced, progressive and A1 mechanic; a special responsible position to such only. Box 87, A. M.

Wanted—Draftsman, in small shop, on fine work; young man, not over 21, also to assist in shop accounting; wages $12. The Durbrow & Hearne Mfg. Co., 8 to 12 Wooster st., New York.

We are enlarging our works, and will shortly require an increased number of skilled mechanics; we invite application from pattern makers, molders and machinists. Address the Westinghouse Machine Company, East Pittsburgh, Pa.

Wanted—A good detail draftsman with experience in locomotive work; must be quick and accurate; state age, experience and salary. Apply to The Canadian Locomotive Company, Limited, Kingston, Canada.

Wanted—Mechanical draftsman, competent to direct operations and make drawings; small machine shop; healthy location in North Carolina; state experience and salary expected. S. Parker, Pine Town, N. C.

Wanted—A first-class machinist for novelty and repair work, capable of making drawings, patterns, etc.; must be steady man; state wages and reference immediately. The Israel "Seeded String" Co., Wichita, Kan.

Wanted—First-class machine shop foreman for New England shop employing 30 men; work is general transmission of power machinery and repairing; only experienced men need apply. Address W., care AM. M.

Wanted—A good machinist who can take charge of machine shop in a bridge works and who understands electrical repair work. Address "A.," care AMERICAN MACHINIST, giving experience, recommendations and wages expected.

Wanted—Foreman machinist, thoroughly familiar with the manufacture of pneumatic hammers; he must be capable of handling men and machines to get out work up to date; steady work and good pay to right man; state age and references. Address Box 40, AM. M.

Wanted—Thoroughly competent foreman on machine tool building, experienced in building pipe threading machinery, familiar with methods of producing duplicate parts on turret lathes; give age, experience, salary expected and references. Box 28, AMER. MACH.

Wanted—Two competent toolmakers with machine shop practice on jigs and fixtures; applicants must be quick in perception and action and have trustworthy recommendations. Apply in person to Superintendent, A. S. Cameron Steam Pump Works, 433 East 23d st., New York.

Wanted—A young man, experienced in office work, familiar with machine tool business or from export house, with knowledge of manufacturers of tools and machinery; must write good hand and be familiar with keeping costs and entering orders; good position to right person. Address Box 59, AM. MACH.

We are erecting new shop buildings and equipping same with all modern appliances; will shortly require an increased number of skilled mechanics; we invite application from machinists, boilermakers and patternmakers; good references must be furnished as to ability and habits. Address Southern Engine & Boiler Works, Jackson, Tenn.

Wanted—Boiler shop foreman, capable of taking charge of shop working from 75 to 100 men at present and will build new plant during the coming year; must have experience in construction of locomotive boilers and tank work, also the use of hydraulic and air tool equipment of the latest design; a first-class position for the proper party. Address "Locomotive Works," care AMERICAN MACHINIST.

Wanted.—Machinists, toolmakers, draftsmen, do you want to increase your salary? They all say that Saunders' enlarged edition "Hand Book Practical Mechanics" exactly fills the bill for valuable shop kinks, rules, etc., figured out by simple arithmetic and drawings; also most complete reference tables in existence, many taken from note books of best mechanics in the country. Pocket size. Price, post paid, only $1, cloth; $1.25 leather. Agents wanted. Book sells itself. Big money. C. H. Saunders, 216 Purchase st., Boston, Mass.

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Babbitt Metal
See Bearing Metal.

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Calipers and Dividers
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Caliper Attachment
Walker Tool Co., Milwaukee, Wis.

Carborundum
See Grinding.

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McKenna & Bro., Jas. J., New York.

Castings, Brass
McKenna & Bro., Jas. J., New York.

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Franklin Mfg. Co., Syracuse, N. Y.

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Pratt & Whitney Co., Hartford, Ct.

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Reed Co., F. E., Worcester, Mass.

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Automobile & Cycle Parts Co., Cleveland, O.
Boston Gear Works, Boston, Mass.
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Whitney Mfg. Co., Hartford, Ct.

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Sterling Watch Tool Co., Rochester, N. Y.

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Le Blond Mach. Tool Co., R. H., Cincinnati, O.
Potter & Johnston Co., Pawtucket, R. I.
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Windsor Mach. Co., Windsor, Vt.

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Brown & Co., R. H., New Haven, Conn.
Cushman Chuck Co., Hartford, Ct.
The E. Horton & Sons Co., Windsor Locks, Conn.
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Standard Tool Co., Cleveland, O.
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Hoggson & Pettis Mfg. Co., New Haven, Conn.
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Skinner Chuck Co., New Haven, Ct.
Westcott Chuck Co., Oneida, N. Y.
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Caldwell, Son & Co., H. W., Chicago, Ill.
Eastern Mchry. Co., New Haven, Conn.
Patterson, Gottfried & Hunter, Ltd., New York.

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Allington & Curtis Mfg. Co., Saginaw, Mich.

Compressors, Air
Curtis & Co.Mg. Co., St. Louis, Mo.
Ingersoll-Sergeant Drill Co., N. Y.
Rand Drill Co., New York.
Standard Pn. Tool Co., Aurora, Ill.

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Cutler-Hammer Mfg. Co., Milwaukee, Wis.

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Long & Allstatter Co., Hamilton, Ohio.

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Builders' Iron Fdry., Provi., R. I.
Reeves Pulley Co., Columbus, Ind.
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Patterson, Gottfried & Hunter, Ltd., New York.
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Veeder Mfg. Co., Hartford, Conn.

Counting and Printing Wheels
Grant Mfg. & Mach. Co., Bridgeport, Conn.

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Brown Hoisting Mach. Co., N. Y. City.
Cleveland Crane & Car Co., Cleveland, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Franklin Portable Crane & Hoist Co., Franklin, Pa.
Maris Bros., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Wm., Philadel., Pa.
Whiting Foundry Equipment Co., Harvey, Ill.

Crank Pin Turning Machines
Underwood & Co., H. B., Phila, Pa.

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Dixon Crucible Co., Jos., Jersey City, N. J.

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Obermayer Co., S., Cincinnati, O.
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Brown & Sharpe Mfg. Co., Providence, R. I.
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Gay & Ward, Athol, Mass.
Geometric Drill Co., Westville, Ct.
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Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Ct.
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Standard Tool Co., Cleveland, O.

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Franklin Mach. Wks., Phila., Pa.
Huribut-Rogers Mach. Co., South Sudbury, Mass.
Newton Mach. Tool Wks., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Ct.

Cutting off Tool
Armstrong Bros. Tool Co., Chicago, Ill.

Dies, Sheet Metal
Bliss Co., E. W., Brooklyn, N. Y.
Perkins Mch. Co., Boston, Mass.

Dresser, Emery Wheel
Wrigley, Thos., Chicago, Ill.

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Bickford Drill & Tool Co., Cincinnati, O.
Dallett & Co., Thos. H., Phila., Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Bench
Barnes Co., W. F. & John, Rockford, Ill.

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Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mch. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati Ohio.
Dallett & Co., Thos. H., Phila., Pa.
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Harrington, Son & Co., Edwin., Philadelphia, Pa.
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Niles-Bement-Pond Co., N. Y. City.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros., Worcester, Mass.

Drilling Machines, Pneumatic
Cleveland Pneu. Tool Co., Cleveland, Ohio.
Standard Pneumatic Tool Co., Aurora, Ill.

Drilling Machines, Portable
Dallett & Co., Thos H., Phila., Pa.

Drilling Machines, Radial
Amer. Tool Wks. Co., Cincin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, Ohio.
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Niles-Bement-Pond Co., New York.
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Quint, A. D., Hartford, Conn.

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Am. Tool Wks. Co., Cincinnati, O.
Baird Mch. Co., U., Pittsburgh, Pa.
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New Haven Mfg. Co., New Haven, Conn.
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Prentice Bros. Co., Worcester, Mass.
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Slocomb & Co., J. T., Providence, R. I.

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Flather & Co., Nashua, N. H.

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Morse, Williams & Co., Phila., Pa.

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See Grinding Wheels.

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Chandler & Taylor Co., Indianapolis, Ind.
Frick Co., Waynesboro, Pa.
Rand Drill Co., New York.

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Fans, Exhaust
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Fans, Electric
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Wyman & Gordon, Worcester, Mass.

Forgings, Hydraulic
Wyman & Gordon, Worcester, Mass.

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Obermayer Co., S., Cincinnati, O.
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Am. Gas Furnace Co., N. Y. City.

Gages, Recording
Bristol Co., Bridgeport, Conn.

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Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb & Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Gages, Steam
Crosby Steam Gage & Valve Co., Boston, Mass.

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Am. Gas Furnace Co., N. Y. City.

Gear Cutting Machinery
Bickford Drill & Tool Co., Cin., O.
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Gould & Eberhardt, Newark, N. J.
Harrington & Son Co., Edwin, Philadelphia, Pa.
Newton Mch. Tool Wks., Phil., Pa.
Pratt & Whitney Co., Hartford, Conn.

Gears, Cut
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Boston Gear Wks., Boston, Mass.
Cleveland Gear Wks., Cleveland, O.
Fawcus Mach. Co., Pittsburgh, Pa.
Gleason Tool Co., Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott, Cleveland, O.
New Process Raw Hide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburgh, Pa.

Gears Molded
Farrel Fdry & Mch. Co., Ansonia, Conn.
Greenwald Co., I. & E., Cincin., O.
Poole & Son Co., Robt., Baltimore, Md.

Gears, Rawhide
Chicago Raw Hide Co., Chicago, Il.
New Process Raw Hide Co., Syracuse, N. Y.

Graphite
Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

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Leland & Faulconer Mfg. Co., Detroit, Mich.
Russell, R. M., Binghamton, N. Y.

Grinders, Cock
Windsor Mach. Co., Windsor, Vt.

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Cincinnati Milling Mach. Co., Cincinnati, O.
Garvin Mach. Co., New York.
Gould & Eberhardt, Newark, N. J.
Norton Emery Wheel Co., Worcester, Mass.
Rivett-Dock Co., Boston, Mass.

Grinder, Cutter Attachment
Russell, R. M., Binghamton, N. Y.

Grinders, Disc
Gorton Mach. Co., Geo., Racine, Wis.
Universal Mach. Co., Provi., R. I.

Grinders, Drill
Gorton Mach. Co., Geo., Racine, Wis.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Tool
Anderson Tool Co., Anderson, Ind.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Gisholt Mach. Co., Madison, Wis.
Landis Tool Co., Waynesboro, Pa
Leland & Faulconer Mfg. Co., Detroit, Mich.
Safety Emery Wheel Co., Springfield, O.
Whitney Mfg. Co., Hartford, Ct.

Grinding Machines
Anderson Tool Co., Anderson, Ind
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders' Iron Foundry, Providence, R. I.
Gorton Mach. Co., Geo., Racine, Wis.
Hill, Clarke & Co., Boston, Mass.
Landis Tool Co., Waynesboro, Pa
Northern Elec. Mfg. Co., Madison, Wis.
Norton Emery Wheel Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, Mass.
Universal Mach. Co., Provi., R. I.
Webster & Perks Tool Co., Springfield, O.
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Safety Emery Wheel Co., Springfield, O.

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Hoefer Mfg. Co., Freeport, Ill.

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Pratt & Whitney Co., Hartford, Ct.

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Dallett & Co., Thos. H., Phila., Pa.
Standard Pneumatic Tool Co., Aurora, Ill.

Hammers, Steam
Cleveland Punch & Shear Wks Co., Cleveland, O.
Crawshaw & Judd, Worcester, Mass.
Niles-Bement-Pond Co., New York.
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Schacht Mfg. Co., Cincinnati, O.

Heads, Exhaust
Burt Mfg. Co., Akron, O.

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C & C Electric Co., New York.
Hunt Co., C. W., West New Brighton, N. Y.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger, Milwaukee, Wis.

Hoists, Hand
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic
Cleveland Pneumatic Tool Co., Cleveland, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Northern Engineering Wks., Detroit, Mich.
Rand Drill Co., New York.
Standard Pneumatic Tool Co., Aurora, Ill.

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Caldwell & Son Co., H. W., Chicago, Ill.
Eastern Mchy. Co., New Haven, Conn.
Hunt Co., C. W., West New Brighton, N. Y.
Link Belt Engineering Co., Philadelphia, Pa.

Indicators, Steam
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Injectors
Lunkenheimer Co., Cincinnati, O.
Sellers & Co., Wm., Phila., Pa.

Inspection and Tests
Hunt Co., Robt. W., Chicago, Ill.

Instruments, Drawing
Keuffel & Esser Co., New York.

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Hartford Steam Boiler Insp. & Ins. Co., Hartford, Conn.

Jacks, Hydraulic
Watson-Stillman Co., New York.

Joints, Universal
Baush Machine Tool Co., Springfield, Mass.
Gray & Prior Mach. Co., Hartford, Conn.

Key Seaters
Baker Bros., Toledo, O.
Chattanooga Mchy. Co., Chattanooga, Tenn.
Mitts & Merrill, Saginaw, Mich.

Keys, Machine
Standard Gage Steel Co., Beaver Falls, Pa.
Whitney Mfg. Co., Hartford, Ct.

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General Electric Co., N. Y City.
Gen. Incan. Arc Light Co., N. Y.
Lea Elec. Mfg. Co., Anderson, Ind.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.

Lathes, Bench
Faneuil Watch Tool Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Ct.

Lathe Dogs
Armstrong Bros. Tool Co., Chicago, Ill.
Le Count, Wm. G., So. Norwalk, Conn.
Schwickart, Ph., Brooklyn, N. Y.

Lathe Feed
Nat'l. Mach. Tool Co., Cincin., O.

Lathes
American Tool Wks. Co., Cin., O.
Automatic Mach. Co., Bridgeport, Conn.
Baird Machy. Co., U., Pittsburgh, Pa.
Barker & Chard Mach. T. Co., Cincinnati, O.
Barnes Co., B. F., Rockford, Ill.
Barnes, W. F. & John, Rockford, Ill.
Bradford Mach. Tool Co., Cin., O.
Bullard Mach. Tool Co., Bridgeport, Conn.
Flather Planer Co., Mark, Nashua, N. H.
Garvin Mach. Co., New York.
Grant Tool Co., Franklin, Pa.
Harrington, Son & Co., Edwin., Philadelphia, Pa.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
McCabe, J. J., New York.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Reed Co., F. E., Worcester, Mass.
Schumacher & Boye, Cincinnati, O.
Sebastian Lathe Co., Cincin., O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Letters, Pattern
Butler, A. G., N. Y. City.

Levels
Starrett Co., L. S., Athol, Mass.

Lockers, Clothes
Merritt & Co., Philadelphia, Pa.

Locomotives, Shop
Hunt Co., C. W., West New Brighton, N. Y.

Lubricants
Dixon Crucible Co., Jos., Jersey City, N. J.

Lubricators
Bowen Mfg. Co., Auburn, N. Y.
Lunkenheimer Co., Cincinnati, O.

Machinists' Small Tools
Billings & Spencer Co., Hartford, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hammacher, Schlemmer & Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Ct.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb & Co., J. T., Provi., R. I.
Standard Tool Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., E. Boston, Mass.

Machinery Builders, Special
Blanchard Mach. Co., The, Boston, Mass.
Watson Mach. Co., Paterson, N. J.

Machine Screws
Worcester Mach. Screw Co., Worcester, Mass.

Mandrels, Expanding
Nicholson & Son, W. H., Wilkesbarre, Pa.

Mandrels, Solid
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Rogers, John M., Boat, Gage & Drill Works, Gloucester City, N. J.

Measuring Machines
Pratt & Whitney Co., Hartford, Ct.
Rogers, John M., Boat, Gage & Drill Works, Gloucester City, N. J.

Micrometer Calipers
Brown & Sharpe Mfg. Co., Providence, R. I.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb & Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Milling Attachments
The Adams Co., Dubuque, Iowa.
Cincinnati Milling Mach. Co., Cincinnati, O.
Kempsmith Mfg. Co., Milwaukee, Wis.

Milling Machines, Bench
Faneuil Watch Tool Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Ct.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Horizontal
Adams Co., Dubuque, Iowa.
Beaman & Smith Co., Provi., R. I.
Franklin Mach. Wks., Phila., Pa.
Grant Tool Wks., Franklin, Pa.
Hendey Mach. Co., Torrington, Ct.
Ingersoll Mill. Mach. Co., Rockford, Ill.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.

Milling Machines, Plain
American Tool Wks. Co., Cin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mach. Co., Cincinnati, O.
Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Kempsmith Mfg. Co., Milwaukee, Wis.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Whitney Mfg. Co., Hartford, Ct.

Milling Machines, Portable
Underwood & Co., H. B., Philadelphia, Pa.

Milling Machines, Universal
Amer. Tool Wks. Co., Cincin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mach. Co., Cincinnati, O.
Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Kempsmith Mfg. Co., Milwaukee, Wis.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Ct.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Vertical
Brown & Sharpe Mfg. Co., Providence, R. I.
Garvin Mach. Co., New York.
Newton Mach. Tool Wks., Philadelphia, Pa.

Molding Machines
The Adams Co., Dubuque, Iowa.
Tabor Mfg. Co., Philadelphia, Pa.
Webster & Perks Tool Co., Springfield, O.

Molds, Soft Hammer
Field, Chas. H., Providence, R. I.

Molds, Vise Jaw
Field, Chas. H., Providence, R. I.

Motors, Electric
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Eddy Elec. Mfg. Co., Windsor, Ct.
General Electric Co., New York.
General Incan. Arc Light Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Robbins & Myers Co., Springfield, Ohio.
Roth Bros. & Co., Chicago, Ill.
Sprague Electric Co., New York.
Triumph Elec. Co., Cincinnati, O.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.

Nut Tappers
See Bolt and Nut Machinery.

Oilers
Bay State Stamping Co., Worcester, Mass.

Oil Cups and Covers
Bowen Mfg. Co., Auburn, N. Y.
Crane Co., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
The Winkley Co., Hartford, Conn.

Packing, Metallic
U. S. Metallic Packing Co., Philadelphia, Pa.

Packing, Steam Joint
Jenkins Bros., New York.

Pans and Tote Boxes
Kilbourne & Jacobs Co., Columbus, Ohio.

Patterns, Wood
Gobeille Pattern Co., Cleveland, O.

Patent Solicitors
Anderson & Co., E. W., Washington, D. C.
Baldwin, Davidson & Wight, Washington, D. C.
Bevans, James W., Washington, D. C.
Copp & Co., Washington, D. C.
Cromwell, W. H., Washington, D. C.

Pattern Shop Machinery
American Machinery Co., Grand Rapids, Mich.
Baker Bros., Toledo, O.
Fay & Scott, Dexter, Me.
Field, Chas. H., Providence, R. I.

Pipe Cutting and Threading Machines
Curtis & Curtis Co., Bridgeport, Conn.
Merrell Mfg. Co., Toledo, O.
Oster Mfg. Co., Cleveland, O.
Saunders' Sons, D., Yonkers, N. Y.

Pipe Fitters' Tools
Saunders' Sons, D., Yonkers, N. Y.
Standard Tool Co., Cleveland, O.

Pipe and Fittings
Crane Co., Chicago, Ill.

Planer, Jack
Armstrong Bros. Tool Co., Chicago, Ill.

Planers
Amer. Tool Wks. Co., Cincin., O.
Belmer-Eames Tool Co., Cin., O.
Betts Mach. Co., Wilmington, Del.
Cincinnati Planer Co., Cincin., O.
Cleveland Punch & Shear Wks. Co., Cleveland, O.
Detrick & Harvey Mch. Co., Baltimore, Md.
Flather Planer Co., Mark, Nashua, N. H.
Garvin Mach. Co., New York.
Gray Co., G. A., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Niles-Bement-Pond Co., New York.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Wks., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Ct.
Sellers & Co., Wm., Phila., Pa.
Whitcomb Mfg. Co., Worcester, Mass.
Woodward & Powell Planer Co., Worcester, Mass.

Planers, Portable
Underwood & Co., H. B., Philadelphia, Pa.

Planers, Rotary
Franklin Mach. Wks., Phila., Pa.
Newton Mch. Tool Works, Philadelphia, Pa.
Underwood & Co., H. B., Phila., Pa.

Presses, Hand
Pratt & Whitney Co., Hartford, Conn.

Presses, Hydraulic
Watson-Stillman Co., New York.

Presses, Power
Bethlehem Fdry. & Mch. Co., So. Bethlehem, Pa.
Bliss Co., E. W., Brooklyn, N. Y.
Perkins Mach. Co., Boston, Mass.

Profilers
Garvin Mach. Co., New York.
Pratt & Whitney Co., Hartford, Ct.

Pulleys
Howard Iron Works, Buffalo, N. Y.
Poole & Son Co., Robt., Baltimore, Md.
Reeves Pulley Co., Columbus, Ind.

Pulleys, Friction Cone
Evans Friction Cone Co., Boston, Mass.

Pulleys, Speed Changing
Speed Changing Pulley Co., Indianapolis, Ind.

Pulley Turning and Boring Machines
Harrington, Son & Co., Edwin, Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.

Pumps, Hydraulic
Watson-Stillman Co., New York.

Punches, Hydraulic
Watson-Stillman Co., New York.

Punches, Power
Bliss Co., E. W., Brooklyn, N. Y.
Bremer Mach. & Tool Co., Kalamazoo, Mich.
Cleveland Punch & Shear Wks., Cleveland, O.
Hilles & Jones Co., Wilmington, Del.
Long & Allstatter Co., Hamilton, Ohio.
Perkins Mach. Co., Boston, Mass.
Pittsburgh Shear Knife & Mach. Co., Pittsburgh, Pa.

Racks, Cut
Standard Gage Steel Co., Beaver Falls, Pa.

Racks, Tool
New Britain Mach. Co., New Britain, Conn.

Rack Cutting Machines
Fellows Gear Shaper Co., Springfield, Vt.
Gould & Eberhardt, Newark, N. J.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Reed Co., F. E., Worcester, Mass.

Reamers
Cleveland Twist Drill Co., Cleveland, O.
Geometric Drill Co., Westville, Ct.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Rogers, John M., Boat, Gage & Drill Wks., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Reaming Stands
Flather & Co., Nashua, N. H.

Recorders, Speed
Starrett Co., L. S., Athol, Mass.

Rheostats
Cutler-Hammer Mfg. Co., Milwaukee, Wis.
General Incan. Arc Light Co., New York.

Riveters, Hydraulic
Watson-Stillman Co., New York.

Riveting Machines
Bethlehem Foundry & Mach. Co., So. Bethlehem, Pa.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Riveters, Pneumatic
Cleveland Pneumatic Tool Co., Cleveland, O.
Standard Pneumatic Tool Co., Aurora, Ill.

Roller and Ball Bearings
Ball Bearing Co., Boston, Mass.
Roller Bearing & Equip. Co., Keene, N. H.

Rolling Mill Machinery
Cleveland Punch & Shear Wks. Co., Cleveland, O.
Diamond Drill & Mch. Co., Birdsboro, Pa.

Safety Valves, Pop
Crane Co., Chicago, Ill.
Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

Sawing Machines, Metal
Cleveland Punch & Shear Works Co., Cleveland, O.
Newton Mach. Tool Works, Philadelphia, Pa.

Schools, Correspondence
Amer. School of Correspondence, Boston, Mass.
Consolidated Schools, N. Y. City.
International Correspon. Schools, Scranton, Pa.

Schools, Technical
Ohio State University, Columbus, Ohio.

Screw Machines, Automatic
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Machine Screw Co., Cleveland, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Screw Machines, Hand
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Mch. Screw Co., Cleveland, O.
Garvin Mach. Co., New York.
Jones & Lamson Mch. Co., Springfield, Vt.
Pearson Mach. Co., Chicago, Ill.
Potter & Johnston Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Warner & Swasey Co., Cleveland, Ohio.

Screw Machinery, Wood and Lag
Baker Bros., Toledo, Ohio.
Cook Co., Asa S., Hartford, Conn.

Screw Plates
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Card Mfg. Co., S. W., Mansfield, Mass.
Hart Mfg. Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Oster Mfg. Co., Cleveland, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Second Hand Machinery
Bowler & Co., Geo. H., Cleveland, Ohio.
Dawson, John H., Chicago, Ill.
Doan & Co., J. B., Chicago, Ill.
Fairbanks Co., Philadelphia, Pa.
Garvin Mch. Co., New York.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mchy. Co., Chicago, Ill.
McCabe, J. J., New York.
Pitkin Machy. Co., J. B., Providence, R. I.
Prentiss Tool & Supply Co., New York.
Toomey, Frank, Philadelphia, Pa.
Wormer Machy. Co., C. C., Detroit, Mich.

Separators, Oil
Amer. Tool & Mch. Co., Boston, Mass.
Springfield Separator Co., Springfield, Vt.

Shapers
Amer. Tool Wks., Co., Cincin., O.
Cincinnati Shaper Co., Cincin., O.
Flather Planer Co., Mark, Nashua, N. H.
Garvin Mach. Co., New York.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., Boston, Mass.
Kelly Co., R. A., Xenia, Ohio.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Perkins Mach. Co., Boston, Mass.
Potter & Johnston Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Ct.
Steptoe & Co., John, Cincinnati, O.

Shears, Rotary
Bethlehem Foundry & Mach. Co., So. Bethlehem, Pa.
Detrick & Harvey Mach. Co., Baltimore, Md.
Perkins Mch. Co., Boston, Mass.

Shears, Power
Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Bliss Co., E. W., Brooklyn, N. Y.
Bremer Mach. & Tool Co., Kalamazoo, Mich.
Cleveland Punch & Shear Wks., Cleveland, O.
Hilles & Jones Co., Wilmington, Del.
Long & Allstatter Co., Hamilton, Ohio.
Perkins Mach. Co., Boston, Mass.
Pittsburgh Shear Knife & Mch. Co., Pittsburgh, Pa.

Shelving, Shop
New Britain Mach. Co., New Britain, Conn.

Slotters
Baker Bros., Toledo, Ohio.
Betts Mach. Co., Wilmington, Del.
Franklin Mach. Wks., Phila., Pa.
Garvin Mach. Co., New York.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.

Slide Rests
Reed Co., F. E., Worcester, Mass.

Springs
Cleveland Wire Spring Co., Cleveland, O.

Sprocket Chains
See Driving Chains.

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Schwerdtle Stamp Co., Bridgeport, Conn.

Stampings, Sheet Steel
Automobile & Cycle Parts Co., Cleveland, O.

Steel, Sheet
Automobile & Cycle Parts Co., Cleveland, O.
Ward & Son, Edgar T., Boston, Mass.

Steel, Machinery
Ward & Son, Edgar T., Boston, Mass.

Straightener, Hydraulic
Watson-Stillman Co., N. Y. City.

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Excelsior Needle Co., Torrington, Conn.

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C & C Electric Co., New York.
Triumph Elec. Co., Cincinnati, O.

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Baker Bros., Toledo, O.
The Beaman & Smith Co., Providence, R. I.
Bickford Drill & Tool Co., Cin., O.
Cincinnati Mach. Tool Co., Cincinnati, O.
Errington, F. A., N. Y. City.
Fosdick & Holloway Mach. Tool Co., Cincinnati, O.
Garvin Mach. Co., New York.
Geometric Drill Co., Westville, Ct.
Gould & Eberhardt, Newark, N. J.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Webster & Perks Tool Co., Springfield, O.

Taps and Dies
Besly & Co., Chas. H., Chicago, Ill.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Crane Co., Chicago, Ill.
Hart Mfg. Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Oster Mfg. Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Threading Dies, Opening
Errington, F. A., New York.
Geometric Drill Co., Westville, Ct.
Jones & Lamson Mch. Co., Springfield, Vt.

Thread Cutting Tools
Hart Mfg. Co., The, Cleveland, O.
Rivett-Dock Co., Boston, Mass.

Tool Holders
Armstrong Bros. Tool Co., Chicago, Ill.

Tools
See Machinists' Small Tools.

Trimmers, Wood
Amer. Mchry Co., Grand Rapids, Mich.
Leland & Faulconer Mfg. Co., Detroit, Mich.

Transmission Machinery
Caldwell & Son Co., H. W., Chicago, Ill.
Link-Belt Engineering Co., Philadelphia, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Reeves Pulley Co., Columbus, Ind.

Trolleys and Tramways
Brown Hoisting Machy. Co., N. Y. City.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hunt Co., C. W., West New Brighton, N. Y.
Link Belt Engineering Co., Philadelphia, Pa.
Maris Bros., Philadelphia, Pa.
Pawling & Harnischfeger, Milwaukee, Wis.
Yale & Towne Mfg. Co., New York.

Turret Machines
Amer. Tool & Mch. Co., Boston, Mass.
Barker & Chard M. T. Co., Cin., O.
Bradford Mach. Tool Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Mach. Tool Co., Bridgeport, Conn.
Cleveland Mach. Screw Co., Cleveland, O.
Dreses, Mueller & Co., Cincin., O.
Garvin Mach. Co., New York.
Gisholt Mch. Co., Madison, Wis.
Grant Tool Co., Franklin, Pa.
Hill, Clarke & Co., Boston, Mass.
Jones & Lamson Mch. Co., Springfield, Vt.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mach Tool Co., Cincinnati, O.
Pearson Mach. Co., Chicago, Ill.
Potter & Johnston Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Ct.
Warner & Swasey Co., Cleveland, Ohio.
Windsor Mach. Co., Windsor, Vt.

Twist Drills
Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & M. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.

Valves
See Steam Fittings.

Vises, Metal Workers'
Howard Iron Works, Buffalo, N. Y.
Parker Co., Chas., Meriden, Conn.
Walworth Mfg. Co., Boston, Mass.

Vises, Pipe
Curtis & Curtis Co., Bridgeport, Conn.
Saunders' Sons, D., Yonkers, N. Y.
Walworth Mfg. Co., Boston, Mass.

Vises, Planer and Shaper
Cincinnati Planer Co., Cincin., O.
Hendey Mach. Co., Torrington, Ct.

Vises, Wood Workers'
Wyman & Gordon, Worcester, Mass.

Welding Machines
Long & Allstatter Co., Hamilton, Ohio.

Wrenches, Drop Forged
Williams & Co., J. H., Brooklyn, N. Y.

Worm Hobbing Machines
Grant Tool Wks., Franklin, Pa.

Worm Gearing
Albro-Clem Elevator Co., Philadelphia, Pa.
Fawcus Mach. Co., Pittsburgh, Pa.
Morse, Williams & Co., Phila., Pa.
Nuttall Co., R. D., Pittsburgh, Pa.

Worm Milling Machines
Cleveland Mach. Screw Co., Cleveland, O.

Electric Shop Locomotives.

In connection with their well-known industrial railways, the C. W. Hunt Company, of West New Brighton, Staten Island, N. Y., have brought out a storage-battery locomotive, of which we give an illustration herewith:

The locomotive is carried on two swiveled four-wheeled trucks, all wheels being drivers, thus enabling the locomotive to ascend heavy grades. The storage batteries are recharged at night or when not in use during the day, the time required for recharging being about one-quarter of the time during which the locomotive is in active service, so that if the locomotive is not required to be in actual service more than about four-fifths of the time the recharging may be done during the intervals between work.

The motors are not mounted between the wheels, as in street-railway practice. With the narrow gage of the track used—21½ inches outside the rail heads—the space available between the wheels is extremely small, and if the motors were so mounted the room below the platform would be filled with motors, gears and connections, making it difficult to inspect the various parts. It would also bring the motors and gears so close to the track that the machinery could not be protected from dust or mud. The motors are therefore mounted on the platform. The gear wheels have machine-cut teeth and are mounted on steel shafts, ground true on dead centers and running in bearings with removable bushings. All the gearing, shafts and bearings are enclosed in an oil-tight circular case, as shown in the illustration, and the gears are lubricated by an oil bath.

For the class of service required of these locomotives, their operation by storage battery is considered a decided advantage over operation by trolley wires. The first cost of the battery is usually less than that of overhead wires, including the expense of erection, and the maintenance is also less than for trolley wires. The battery locomotive can run instantly on any track required or improvised, while the trolley locomotive can run only where wires are installed. Trolley wires cannot be run conveniently in erecting shops, machine shops or near overhead cranes, while the battery locomotive is efficient wherever a track is laid.

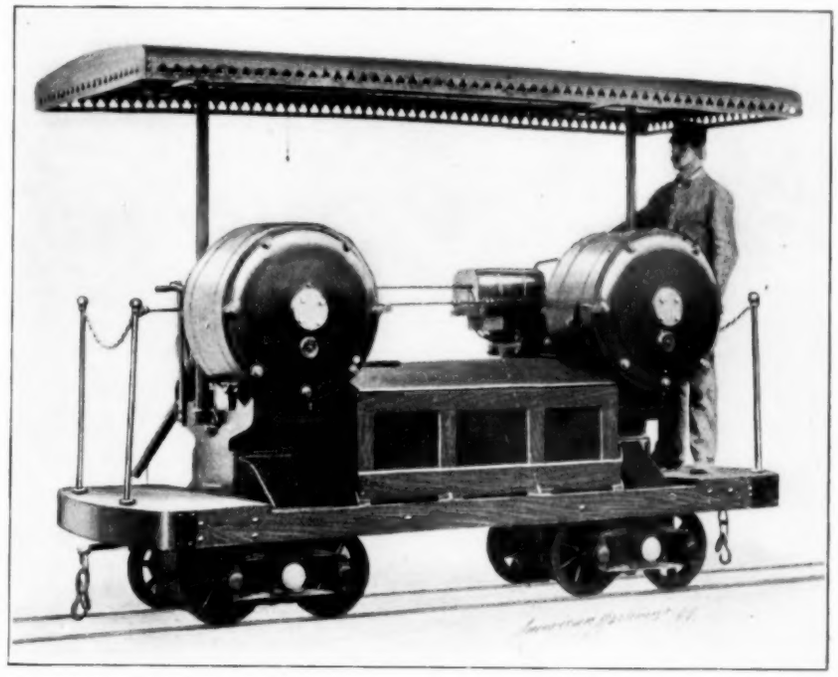
Of course, these locomotives are not recommended for long hauls or long and severe grades, but for use in yards or intermittent work.

The generous proportions of the storage batteries will be appreciated by considering that batteries for automobile work are usually required to deliver about 7 watts per pound of lead, while these batteries are called upon for only 2 watts per pound.

The capacity of the locomotive is equal to hauling 50 tons on the level, which amount is, of course, lessened on grades, the figure for a 5 per cent. grade being 5 tons.

In accordance with the standard practice of the company, the flanges of the wheels are external to the track. All curves used have a radius of 12 feet and the track on curves is so made that in passing a curve the flange of the outside wheel becomes the tread, the inside wheel acting in the usual way. The diameters of tread and flange are so proportioned that, on curves of this radius, the wheels will go around the curve without slipping—a fact which gives the machine the same draw-bar pull on curves as on a straight track. The speed ranges from 1 to 4 miles per hour, and in the usual range of shop and yard work one charge of the batteries will operate the machine for ten hours.

A charging set is included in the outfit, which may be operated by a steam engine or, when electric power is available, by an electric motor. In ordinary service the charging set will supply two or three locomotives.



ELECTRIC SHOP LOCOMOTIVE.

The Strength of Shrouded Gear Teeth.

BY WILFRED LEWIS.

[A New England subscriber has asked us the following questions: 1. What is the gain in strength in gearing due to shrouding the teeth of gears up to the pitch line and up to the tops of the teeth? 2. In the figure of 20,000 lbs. for the safe working stress of steel gear teeth given in "Kent's Pocket Book," is the factor intended for cast steel or machinery steel and would this factor be suitable for cast steel gears with cut teeth or cast steel gears with cast teeth? We referred the questions to Wilfred Lewis, and have received from him the following reply.—Ed.]

I do not know of any careful analyses of or experiments on the strength of shrouded gear teeth, but I have some recollection of a tradition in vogue about twenty-five years ago that from one-fourth to one-half might be added to the strength by shrouding.

There are, however, a number of cases to be considered; the shrouding may extend to the pitch line only or to the ends of the teeth, and it may be single or double. Formerly the practice of shrouding pinions was more common than it is to-day, because the advent of steel as a cheap construction material makes it possible to obtain unshrouded pinions of greater strength than the cast iron gears with which they engage, and now steel pinions have generally supplanted the old cast iron shrouded ones which were naturally more roughly shaped, because harder to fit, and more difficult to assemble by reason of the shrouding. In my investigation of the strength of gear teeth I therefore assumed that the time for shrouded gears has passed, at least as far as machine tools were concerned; but they are possibly used as freely as ever on roll trains and some other classes of machinery, so that the problem may still be worthy of consideration from a practical standpoint. Rankine, in his "Applied Mechanics," rather summarily disposes of the strength of gear teeth by assuming the load that may be carried on one corner to be all that any tooth is good for. When so loaded, it is shown that the corner will break off at an angle of 45 degrees, and the strength of a tooth of any width is then no greater than that of a tooth whose width is twice its hight. So, if the hight of a tooth is .65 pitch, the strength, ac-

cording to Rankine, should be taken for a width of only 1.3 pitch. Faces wider than this would be no stronger, and shrouding at one end would make no difference.

But his assumption is untenable, because no maker of machinery who values his reputation will put gears into service bearing only at one end; and should they be so started, an even distribution of pressure is sooner or later effected by the natural process of wear.

A comparison of strength between shrouded and unshrouded gears should therefore be made on the assumption of uniform distribution of pressure across the faces of their teeth, and for this purpose it will be expedient to neglect the influence of tooth forms, which would complicate and prolong the investigation, and treat all teeth simply as rectangular prisms, which may or may not be supported by shrouding. Rankine and Unwin have both been contented to estimate the actual strength of teeth as though they were rectangular prisms, and, although this is far from the truth, it is certainly more admissible as a basis of comparison for another variable than as an approximation for a direct result. The effect of this assumption will be to exaggerate the value of shrouding, and for the present it will be sufficient to indicate roughly the maximum benefit to be anticipated.

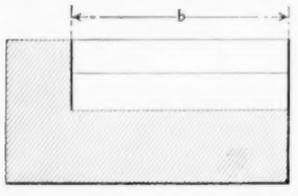
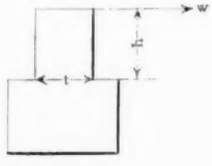


Fig. 1



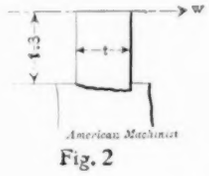


Fig. 2

THE STRENGTH OF SHROUDED GEAR TEETH.

In Fig. 1 a gear tooth is shrouded at one end, and the problem is to determine its strength as compared with the same tooth not shrouded. For convenience, the thickness or half the pitch may be taken as unity, and the hight as 1.3. The load w is assumed to be applied uniformly along the end of the tooth over the face b, making the full load $b\,w$. If there were no shrouding the strength of this tooth would be measured by the transverse resistance at its root t, and if broken at the root as shown in Fig. 2, we may consider how much strength could be given to it by shrouding alone.

A tooth thus broken would have some strength as a cantilever imbedded in the shrouding, but more as a shaft subjected to torsion, and for the shape here assumed the torsional strength alone will probably exceed the combined strength due to torsion, and flexure for any actual shape.

The rectangular tooth whose sides are h and t cannot be treated as an ordinary shaft because its neutral axis is at one side instead of, as usual, at the center of gravity. It must therefore be treated as one half of a shaft whose sides are $t \times 2h$ or 1×2.6, for which the moment of resistance is about $.6\,s$, where s is the shearing stress at the end of a tooth. For the unit load w we have $.6\,s = 1.3\,w$, or $s = 2.17\,w$, and for the width b we have $s_1 = b\,s = 2.17\,b\,w$.

Thus the maximum intensity of shearing s_1 is found to be a little more than twice the full load $b\,w$.

On the other hand, for an unshrouded tooth the transverse stress f at the root of a tooth depends only upon w and the relation is expressed by the equation $f = 7.8\,w$. In these terms,

$$w = \frac{f}{7.8} = \frac{s_1}{2.17\,b}$$

whence $$f = \frac{3.5\,s_1}{b}$$

and assuming that the shearing stress s_1 may be $.8\,f$, we have $b = 2.8$. This means that a tooth 2.8 wide has as much strength as may possibly be added by shrouding at one end; but the question remains to be considered, under what conditions and to what extent can this possible strength be made effective? The development of stress is always accompanied by strain, and in the case of a shrouded tooth the unit load w must be divided between torsion and flexure. Obviously, if the tooth is very long its stiffness under torsion will be so little, as compared with its stiffness under flexure, that the benefit from shrouding will be inappreciable, and on the other hand if very short, the torsional stiffness will be preponderate. When a uniform distribution of load has been attained, as it must be by the action of wear, that part of a tooth farthest from the shrouding will sustain the greatest transverse stress and the load w will be divided at all points along the face of the tooth between torsion and bending directly as the stiffness encountered in these two directions or inversely as the relative strains. Each strain is relieved by the other, but the limit of strength is reached when either attains its maximum.

Considering a cantilever loaded at the end, we have for the deflection y, under the stress f,

$$y = \frac{f\,h^2}{1.5\,E}$$

where $h = 1.3$ and E is the modulus of elasticity for flexure. Substituting this value of h we have:

$$y = \frac{1.1\,f}{E} \qquad (1)$$

Considering the tooth as a rectangular shaft in torsion, it will be seen that the shearing stress for a distributed load decreases from the maximum S_1 at the shrouding to nothing at the other end of the tooth. For the unit load w the shearing stress is S, for an element $d\,x$ the stress is $S\,d\,x$, and for this stress at the distance x from the shrouding the torsional deflection

$$d\,z = \frac{S\,x\,d\,x}{G}$$

where G is the modulus for shearing. The total deflection for the load distributed over a length x therefore is:

$$z = \frac{S\,x^2}{2\,G}$$

or for the face b we have:

$$z = \frac{S\,b^2}{2\,G}$$

But since $G = .4\,E$ we may write:

$$z = \frac{S\,b^2}{.8\,E} \qquad (2)$$

The value of S has been found to be $S = 2.17\,w$, and we have also found $f = 7.8\,w$, therefore:

$$S = \frac{2.17\,f}{7.8} = .28\,f$$

and $$z = \frac{S\,b^2}{8\,E}$$

may be written

$$z = \frac{.35\,f\,b^2}{E} \qquad (3)$$

The deflection of an unshrouded tooth under the load w has been shown by equation (1), and, dividing this into equation (3), we have for the relation between y and z

$$\frac{z}{y} = .36^2.$$

For a very narrow tooth, letting $b = 1$, we have $z = .3\,y$; but since y and z are necessarily equal, when the tooth under consideration is attached at its root and also to the shrouding, the load w will be supported at both points, and it will necessarily be divided between them in the proportion of y to z, or as 1 to .3. The shrouding will carry $\frac{w}{1.3}$, or $.77\,w$, and the root of the tooth $.23\,w$.

Similarly, making $b = 2$, or one pitch, we have $z = 1.2\,y$, and at this point the shrouding will carry $.45\,w$ and the root of the tooth $.55\,w$. Also, when $b = 3$, we have $z = 2.7\,y$, reducing the load on shrouding to $.27\,y$ and increasing the load at the root to $.73\,w$. At $b = 4$, or 2 pitch, $z = 4.8\,y$, the load on shrouding drops to $.17\,w$ and the load at the root rises to $.83\,w$.

The average width of gear faces is probably about 2.5 pitch, and for $b = 5$ we have about $.12\,w$ carried by the shrouding and $.88\,w$ carried by the tooth acting as a cantilever. We may therefore conclude that the strength of an ordinary pinion shrouded at one end only is not increased more than 12-88, or about 13 per cent., by the shrouding. Indeed, this is only the

result of a first approximation, and for the successive proportions of w thus credited to the shrouding new values of z might be estimated to be used as the basis of a second approximation. But we will not continue the process; it is sufficient to know that our valuation of the effect of shrouding is high. A double-shrouded pinion running with a gear whose face is $2.5\,p$ will be about 3 pitch between shroudings and its strength will be about the same as that just found for $b = 3$. An ordinary pinion will not therefore be increased in strength by double shrouding more than 37 per cent., and it is probably safe to say that a more elaborate investigation will reduce the additional strength to 10 per cent. for single shrouding and 30 per cent. for double shrouding.

When the shrouding extends to the pitch line only, the shearing strength of its attachment to a tooth is reduced, but the elastic relations upon which the strength at the root depends remain practically the same. In this case the shearing strength instead of the transverse strength limits the strength of a tooth, and the strength is apparently less than for full shrouding.

The effect of shrouding is clearly to prevent the adjacent part of a tooth from exercising its strength as a cantilever. The shrouding carries what the tooth itself might carry almost as well. A heavy link in a light chain adds nothing to the strength of the chain, and teeth which are not strong all over need not be strengthened in spots. A little more face covering the space occupied by shrouding is more to the purpose for durability as well as for strength, and when this fact is appreciated I believe the practice of shrouding will disappear in rolling mills, as it has done in machine shops.

In regard to the working stress allowable for cast iron and steel, I may say that 8,000 pounds was given as safe for cast-iron teeth, either cut or cast, and that 20,000 pounds was intended for any steel suitable for gearing whether cast or forged. These were the unit stresses recommended for static loads, and as the speed increased they were reduced by an arbitrary factor, depending upon the speed.

The iron should be of good quality capable of sustaining about a ton on a test bar 1 inch square between supports 12 inches apart, and of course the steel should be solid and of good quality. The value given for steel was intended to include the lower grades, but when the quality is known to be high, correspondingly higher values may be assigned.

Mr. Christie has shown that the harder the steel and the higher its elastic limit the better it is adapted to the requirements of high speed in gearing.* Great resilience is needed to absorb the shocks of impact, and when this is provided there is also greater strength to resist static loads.

*Mr. Christie's paper may be found at page 287, Vol 24—Ed.

I would therefore suggest that the static stress in steel gear teeth be taken at about two-thirds of the elastic limit of the material.

In conclusion I may say that the crude investigation here given seems to justify the traditions referred to that from ¼ to ½ may be added to the strength of teeth by shrouding. If the teeth are very narrow, ½ may be added, but generally, I believe, ¼ is enough; and since writing the above I find that D. K. Clark almost splits the difference by adding ⅓ for double shrouding. But the development of the full strength of gear teeth depends nearly as much upon the strength and stiffness of the gear journals as upon the teeth themselves, and no rules can be given for indiscriminate use.

While I believe shrouding to be a bad practice that ought to be abandoned, I hope some light may be thrown upon the subject by practical experiments. I await such enlightenment.

Experiments on the Flexure of Beams—Discovery of New Laws—VII.

BY ALBERT E. GUY.

THE SHAPE OF THE BEAM.

For a beam of length L rigidly held at one end and supporting at the other a load P producing flexure only, the bending moment $P\,x$ for any section distant a length x from the point of application of the load is equal to the moment of resistance $f\frac{I}{a}$ of the section. As we have seen previously, this is expressed by equation (1): $P\,x = f\frac{I}{a}$ in which x is a quantity varying from zero at the loaded point to L at the holding point. P being constant, it follows that the second term must vary in order to preserve the equation. If we make f a constant, the modulus of section $\frac{I}{a}$ will vary directly as x and the beam in such a case is called a solid uniform resistance. If $\frac{I}{a}$ is made constant, the section of the beam is uniform throughout the length. The area A of the transverse section fluctuates in the same manner as $\frac{I}{a}$ and is therefore greatest for the value of this latter corresponding to $x = L$. For $x = o$ we have $\frac{I}{a} = 0$ and the area $A = o$. But as the load must have a support, the end of the beam, instead of having a sectional area $= o$, is always made substantial enough to resist the vertical shearing produced by the load. Apart from this consideration we can see that a beam has a lesser volume when made of uniform strength instead of with a uniform section.

The preceding remarks are well known and are extensively developed in text books. The quantity $\frac{I}{a}$ is indeterminate in this sense that it applies to any form of section, regular or otherwise, and consequently it shows that a beam can be made uniformly strong in an infinity of manners. It does not follow that the volume will remain constant whatever is the shape selected for the beam; on the contrary, variations in shape generally cause variations of volume. Since this latter may vary so widely there must be a certain shape for which the volume of the beam is a minimum. The truth of this assertion is well established and for plain transverse sectioned beams the shape having the lesser volume can be mathematically determined—and with ease. For instance, in Reuleaux's Constructor there are shown fifteen forms of beams of uniform resistance to flexure, together with the equations of the shape and of the volume of each solid. The largest or main section being calculated and the shape of the beam selected, this latter may be delineated according to the proper equation, thus saving the trouble to calculate a great number of sections by a cut and try method. The fifteen forms given by Reuleaux are meant only for beams of rectangular section, but we will see later on that they can be utilized for any form of section, under certain conditions. Among them, that which has a minimum volume, has a section with a constant hight H and a varying width B.

It is not so easy to proceed when the form of the section is a complicated one—like I or T, for instance. Each section to be calculated must generally be roughly estimated at first, and finally determined by successive approximations. The work involved by this process is, of course, very tedious, and the results obtained thereby have not all the exactness that could be desired.

In the following the writer gives a new law which will be found of great help to the delineator, in that it will enable him to determine rapidly and rigorously the form of any beam of uniform strength.

The New Law.—*The maximum transverse section of a beam of length* L *being divided (rightly conceived as such for the purpose of delineating only, the adherence of the parts being unaffected) into any number of parts—equal, similar or otherwise.* 1. *Any one part may be treated independently of the others, provided that the same form of treatment is applied to the others one by one or altogether;* 2. *Each part may be considered as the transverse section of a beam or elementary prism of length* L; 3. *The size of the transverse section of such a prism at any point along* L *depends only on the value of the bending moment* P x *at that point;* 4. *Consequently each prism will be of uniform strength, and the combination of all the prisms or the solid beam will also be of uniform strength.*

Demonstration: Let Fig. 26 represent a beam held at one end and loaded at the

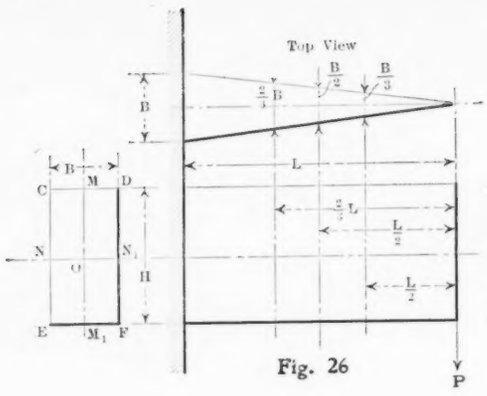


Fig. 26

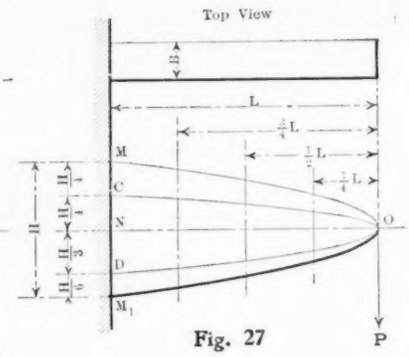


Fig. 27

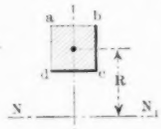


Fig. 28

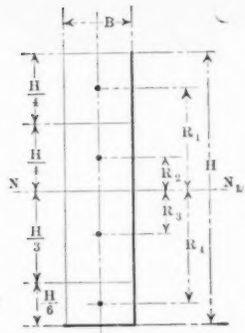


Fig. 29

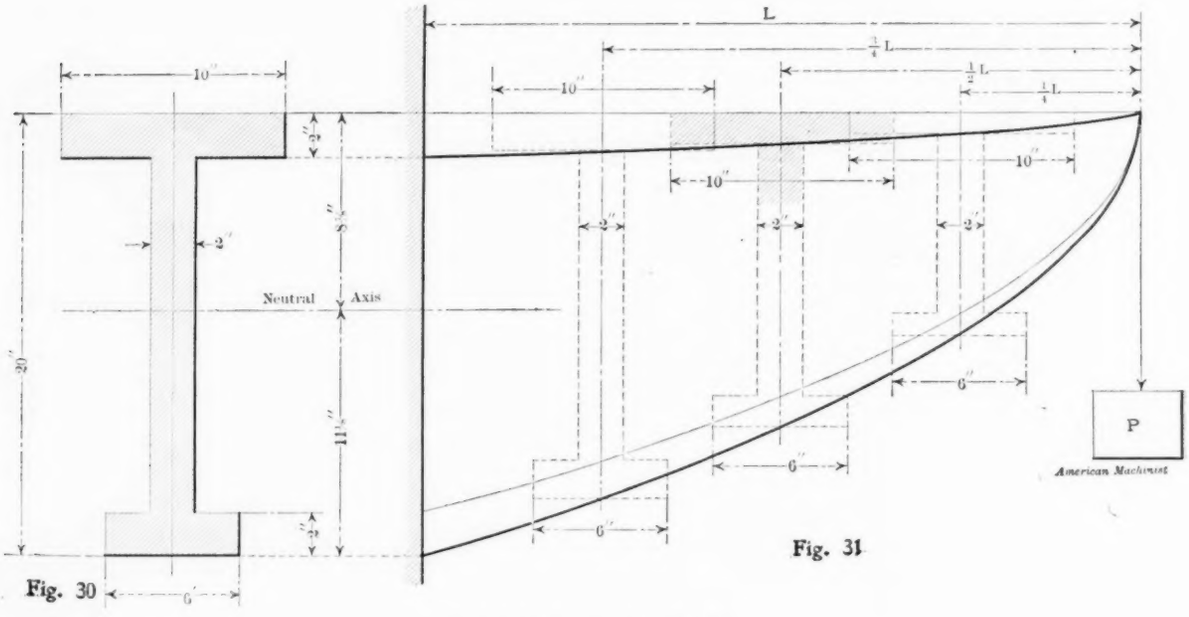


Fig. 30

Fig. 31

BEAMS OF UNIFORM STRENGTH.

other. For simplicity's sake the transverse section is made rectangular and the equation of the bending moment is, as we have seen before, $P x = f \frac{B H^2}{6}$.

If we make the hight H constant, the stress f being constant—since the beam must be of uniform strength—we have for the value of B at any section distant a length x from the point of application of the load:

$$B = K x, \text{ where } K = \text{constant} = \frac{6P}{fH^2}.$$

H must be determined at first for the maximum section. Where $x = L$ then we see that B varies directly as x, and since $B = K x$ is the equation of a straight line the plan or top view of the beam will be, as shown, a rectilinear triangle. If B is the width of the main section for $x = L$ then for $x = \frac{L}{3}, \frac{L}{2}, \frac{2L}{3}$, etc., the width of the sections will be respectively $\frac{B}{3}, \frac{B}{2}, \frac{2B}{3}$ etc.

Now let the rectangle $C D E F$ represent the main section, $N N_1$ is the neutral axis and $M M_1$ the vertical axis. We may conceive this section as being the sum of the two triangles $C M M_1 E$ and $M D F M_1$ equal to one another, each of which is the section of a prism of hight H, base B and length L, sustaining at one end a load $\frac{P}{2}$ or half the total load. Keeping the hight H constant, the width B_1 of each prism for any length x will be $B_1 = \frac{Kx}{2}$, the sum of the widths will be $2 B_1 = 2 \left(\frac{Kx}{2} \right) = B$, or just what we had previously for a whole prism of the same length.

It is evident that the section being divided into any number—say, an infinity—of rectangles of same hight H, if all are treated similarly, the sum of the widths of the prisms will be equal to that B of the solid prism for any length x.

We can prove in the same manner that if the section is divided into any number of parts the constant hight H will equal the sum of the individual hights of these parts, and the width B will likewise equal the sum of the individual widths. This case is so simple that no demonstration is necessary.

Let us now make the width B constant throughout the length L, then for any length x we will have:

$$H^2 = \frac{6 P x}{B f}, \text{ whence } H = \sqrt{\frac{6 P x}{B f}} = K_1 x,$$

where $K_1 = \text{constant} = \sqrt{\frac{6 P}{B f}}$.

By means of this equation we can delineate the shape of the solid prism, the elevation of which is shown in Fig. 27, the top and bottom contour lines being parabolas. Should one of the contour lines be made straight—as is often the case in practice—the other would be a parabola, but the hight of a section at a given point would remain the same in either case.

Since B is constant, if we divide the section into any number of rectangles, the sum of the widths of the prisms thus formed will be a constant throughout the length and equal to B.

Before proceeding further let us recall the equation expressing the moment of inertia of a section taken with respect to an axis lying in the same plane, as shown in Fig. 28. The center of gravity of section $a b c d$ is distant a length R from the given axis $N N_1$. In treatises on applied mechanics it is shown that the mo-

ment of inertia I taken with respect to $N N_1$ equals the inertia moment i of the section $a\,b\,c\,d$, plus the product of the sectional area A by the square of the radius of giration R, or:

$$I = i + A R^2. \qquad (32)$$

As an example, let us find the moment of inertia of the rectangular section of the beam shown in Fig. 26. If we conceive the section as divided into two equal parts by the neutral axis $N N_1$, then, according to formula (32), we have for the upper part:

$$\frac{I}{2} = \frac{B}{12} \cdot \left(\frac{H}{2}\right)^3 + B \cdot \frac{H}{2} \times \left[R^2 = \left(\frac{H}{4}\right)^2\right]$$

$$\frac{I}{2} = \frac{B H^3}{24}.$$

The moment of inertia of the lower part has the same value, and their sum is, as we know:

$$I = 2\left(\frac{I}{2}\right) = 2\left(\frac{B H^3}{24}\right) = \frac{B H^3}{12}$$

If a rectangular section having a moment of inertia $I = \frac{BH^3}{12}$ was divided into four equal parts the moment of each part, beginning from the top, would be:

$$\frac{B H^3}{12 \times 64}, \quad \frac{B H^3}{12 \times 64}, \quad \frac{B H^3}{12 \times 27}, \quad \frac{B H^3}{12 \times 216}$$

The radii of giration are respectively: $R_1 = \frac{3}{8} H$, $R_2 = \frac{1}{8} H$, $R_3 = 1\text{-}6\,H$, $R_4 = \frac{5}{12} H$. The moments of inertia of these parts with respect to $N N_1$ are respectively:

$$i_1 = \frac{B H^3}{12\times 64} + \frac{BH}{4} \times \frac{9}{64} H^2 = \frac{7}{16} \cdot \frac{BH^3}{12} = \frac{7}{16} I$$

$$i_2 = \frac{B H^3}{12\times 64} + \frac{BH}{4} \times \frac{1}{64} H^2 = \frac{1}{16} \cdot \frac{BH^3}{12} = \frac{1}{16} I$$

$$i_3 = \frac{B H^3}{12\times 27} + \frac{BH}{3} \times \frac{1}{36} H^2 = \frac{4}{27} \cdot \frac{BH^3}{12} = \frac{4}{27} I$$

$$i_4 = \frac{B H^3}{12\times 216} + \frac{BH}{6} \times \frac{25}{144} H^2 = \frac{19}{54} \cdot \frac{BH^3}{12} = \frac{19}{54} I$$

$$\left.\begin{matrix} \text{Total} \\ I \end{matrix}\right\} = \ldots\ldots\ldots\ldots \frac{BH^3}{12} = I$$

We can easily conclude without further proof that the moment of inertia of a section, whatever may be its shape, is equal to the sum of the individual moments of its parts.

For the present case equation (1): $P x = f \frac{I}{a}$ may be written:

$$P x = \left(\frac{i_1 + i_2 + i_3 + i_4}{a}\right)$$

and if the section had been divided into a number n of parts such that the moments of inertia of these with respect to $N N_1$ be equal to one another, we would have,

$$P x = f \frac{n\, i_n}{a}$$

Hence, were it wanted to calculate the longitudinal dimensions of each prism, it would be correct to write:

$$\frac{P}{n} x = f \frac{i_n}{a}$$

In other words, each part furnishes its quota of molecular resistance according to the value of its moment of inertia, and, corresponding to this, the bending moment for this part is equal to the total bending moment divided by the total moment of inertia and multiplied by the moment of inertia of the part considered. For instance, for the top part of the rectangular section just considered, we would have:

$$\frac{P x \times i_1}{I} = f \frac{i_1}{a} = \frac{7}{16} P x.$$

Taking again equation (1) for the maximum section we have:

$$P L = f \frac{I}{a}$$

and for any other section:

$$P x = f \frac{I_1}{a_1}$$

whence

$$\frac{x}{L} = \frac{\left(\frac{I_1}{a_1}\right)}{\left(\frac{I}{a}\right)} \qquad (33)$$

If we designate by i and i_1 the moments of inertia of a part corresponding respectively to L and x, we have:

$$\frac{i\,PL}{I} = f \frac{i}{a}; \quad \frac{i\,Px}{I} = f \frac{i_1}{a_1}$$

whence by combining these expressions:

$$\frac{x}{L} = \frac{i_1}{i} \cdot \frac{a}{a_1} \qquad (34)$$

comparing equations (33) and (34), we have:

$$\frac{x}{L} = \frac{I_1}{I} \cdot \frac{a}{a_1} = \frac{i_1}{i} \cdot \frac{a}{a_1}$$

whence

$$\frac{I_1}{I} = \frac{i_1}{i} \quad \text{or} \quad \frac{i}{I} = \frac{i_1}{I_1} \qquad (35)$$

This point is exceedingly important, for we see now that for two positions L and x, the moments of inertia *total* I and I_1 and the partial moments i and i_1 bear the same ratio; thus, if we write $\frac{I_1}{I} = m$, we have also $\frac{i_1}{i} = m$.

If we call i_0 and i_0^1 the moments of inertia proper of the partial section referred to its own axis and corresponding respectively to L and x, we have by equation (32):

$$i = i_0 + (\text{area} \times R^2),$$

$$i_1 = i_0^1 + (\text{area}_1 \times R_1^2).$$

Since $\frac{i_1}{i} = m$, $i_1 = i\,m$, whence:

$$i_1 = i_0 m + (\text{area} \times R^2)\, m.$$

Let us make

$$i_0 = \frac{b h^3}{12} \text{ and } i_0^1 = \frac{b_1 h_1^3}{12} = i_0 m.$$

Then

$$\frac{x}{L} = \frac{i_1}{i} \frac{a}{a_1} = \frac{a}{a_1} \left(\frac{\frac{b_1 h_1^3}{12} + A R^2 m}{\frac{b h^3}{12} + A R^2}\right)$$

whence

$$a_1 x \left(\frac{b h^3}{12} + A R^2\right) = a L \left(\frac{b_1 h_1^3}{12} + A R^2 m\right)$$

$$a_1 x \left(\frac{b h^3}{12}\right) - a L \left(\frac{b_1 h_1^3}{12}\right) = a L\, A R^2 m$$

$$- A R^2 a_1 x = A R^2 (a L m - a_1 x);$$

but $a L m - a_1 x = 0$, hence

$$a_1 x \left(\frac{b h^3}{12}\right) = a L \left(\frac{b_1 h_1^3}{12}\right)$$

and, finally,

$$\frac{a_1 x}{a L} = \frac{b_1 h_1^3}{b h^3} = \frac{i_1}{i} = \frac{I_1}{I} = \frac{i_1^1}{i_0}$$

Now, if we remark that:

$$I = \frac{B H^3}{12} \quad i_0 = \frac{b h^3}{12} \quad a = \frac{H}{2}$$

$$I_1 = \frac{B_1 H_1^3}{12} \quad i_0^1 = \frac{b_1 h_1^3}{12} \quad a_1 = \frac{H_1}{2}$$

and also that, in the present case, we have assumed the width B to remain constant, we arrive at the conclusion that:

$$\frac{x}{L} = \frac{H_1^2}{H^2} = \frac{h_1^2}{h^2} \qquad (36)$$

Generally it is preferable to use the expression:

$$\frac{x}{L} = \frac{B_1 H_1^2}{B H^2} = \frac{b_1 h_1^2}{b h^2} = \left(\frac{I_1}{a_1}\right)\left(\frac{a}{I}\right) \qquad (37)$$

which means that *any partial section* b h, *however small, will vary throughout the length of the beam in the same proportion as the main section* B H. This curious conclusion would be of little value in the case of a beam of rectangular section, because the variation of the section—as a whole—at different points lengthwise can be easily plotted, but it becomes valuable when it can be proven to hold good for a beam of any transverse section, as will be illustrated in the second of the following examples. This ends the demonstration, but in order to help the understanding of it and also to show fully the great advantages to be derived from the application of this new law, two practical examples are given herewith:

FIRST EXAMPLE.

Let the main transverse section—at the point of support—of a beam of length L, *held horizontally at one end and holding at the other a load* P, *be rectangular and divided, as shown in Fig.* 29. *Find the dimensions of the partial and main sections at three places corresponding respectively to* $x = \frac{L}{4}, \frac{L}{2}, \frac{3L}{4}$, *the thickness* B *of the beam remaining constant.*

Solution.—Fig. 27 represents a longitudinal elevation of the beam, lines $M O$ and $M_1 O$ being the outlines of the beam; lines $C O$, $D O$ and $N O$ are the outlines of the partial longitudinal sections of the beam, corresponding to the partial transverse sections. Line $N O$ is also the neutral axis.

Let us find at first the hight H of the sections at the points considered:

The maximum bending moment is $P L = f \frac{B H^2}{6}$, and for any length x we have $P x = f \frac{B_1 H_1^2}{6}$, whence

$$\frac{x}{L} = \frac{B_1 H_1^2}{B H^2}.$$

The width B being constant we have $\frac{x}{L} = \frac{H_1^2}{H^2}$. Solving for the unknown quantity H_1, we have:

$$H_1 = H\sqrt{\frac{x}{L}}$$

Then, for $x =$	$\frac{L}{4}$	$\frac{L}{2}$	$\frac{3}{4}L$
$H_1 = H\sqrt{\frac{1}{4}}$			
$= \frac{H}{2}$		$H\sqrt{\frac{1}{2}}$	$H\sqrt{\frac{3}{4}}$
		$0.707\ H$	$0.866\ H$

Now, for any partial section, we also have $h_1 = h\sqrt{\frac{x}{L}}$

Hence for $x =$	$\frac{L}{4}$	$\frac{L}{2}$	$\frac{3}{4}L$
Partial section s_1 $h_1 =$	$\frac{H}{4}\times\frac{1}{2} = \frac{H}{8}$	$\frac{H}{4}\times 0.707 = 0.1768\ H$	$\frac{H}{4}\times 0.866 = 0.2165\ H$
s_2 $h_2 =$	$\frac{H}{4}\times\frac{1}{2} = \frac{H}{8}$	$\frac{H}{4}\times 0.707 = 0.1768\ H$	$\frac{H}{4}\times 0.866 = 0.2165\ H$
s_3 $h_3 =$	$\frac{H}{3}\times\frac{1}{2} = \frac{H}{6}$	$\frac{H}{3}\times 0.707 = 0.2357\ H$	$\frac{H}{3}\times 0.866 = 0.2886\ H$
s_4 $h_4 =$	$\frac{H}{6}\times\frac{1}{2} = \frac{H}{12}$	$\frac{H}{6}\times 0.707 = 0.1278\ H$	$\frac{H}{6}\times 0.866 = 0.1443\ H$
Sum of partial heights . . $H_1 =$	. . . . $\frac{H}{2}$	. . . . . $0.707\ H$	. . . . . $0.866\ H$

These figures are not absolutely necessary to establish the proof, but were needed for making the drawing of Fig. 27. The hight H being composed of four parts, if we multiply each of these by a common factor, the sum of the products is equal to the product of the whole hight by said factor; thus:

$$\left(\frac{H}{4}\times 2\right)+\left(\frac{H}{4}\times 2\right)+\left(\frac{H}{3}\times 2\right)+\left(\frac{H}{6}\times 2\right)$$
$$=\left(\frac{H}{4}+\frac{H}{4}+\frac{H}{3}+\frac{H}{6}\times 2\right) = H\times 2.$$

SECOND EXAMPLE.

Let the main section of the beam be of T-shape, as shown in Fig. 30. Find the dimensions of the main and partial sections for $x = \frac{L}{4}, \frac{L}{2}, \frac{3}{4}L$. *1°, the width remaining constant; 2°, the hight remaining constant; 3°, the width varying in a determined manner.*

Solution I.—A first glance at the proposed transverse section reveals the fact that the material comprising the beam resists in a different degree compressive or tensile stresses. Effectively the material is so distributed throughout the section that the upper part—resisting tensile stresses—has a lesser maximum stress f_t than the lower part, which works in compression (f_c). (The intensity of the stresses developed in the beam varies as the distance of the part considered from the neutral axis.) But this fact does not hinder us in any way; on the contrary, it will render the proof of the law more palpable.

We may divide the main section into four parts: Two above the neutral axis, *i. e.*, the top flange (10x2 inches), the web (2x6⅞ inches); and two below the axis, *i. e.*, the web (2x9⅛ inches) and the lower flange (6x2 inches). Since it is required that the width is to remain constant, we will make the top and bottom flanges and the web respectively 10, 6 and 2 inches wide throughout the length.

We will multiply the main hight of each partial section successively by $\sqrt{\frac{3}{4}}$, $\sqrt{\frac{1}{2}}$, $\sqrt{\frac{1}{4}}$, and with the products obtained as ordinates and $\frac{3}{4}L$, $\frac{1}{2}L$, $\frac{1}{4}L$ respectively as abscissæ points will be determined through which contour lines will be drawn as shown in Fig. 31. The resulting transverse sections are shown in dotted lines at their respective places. The tables of transverse sections given herewith prove beyond doubt that the simple method employed for this solution is correct.

It should be understood that the case just treated is taken as an example only to prove the law, as the resulting shape may be found very inconvenient and difficult of execution.

Solution 2.—The hight remaining constant, the widths of the flanges and web will taper gradually to a line at the place of application of the load, theoretically, just as in Fig. 26. The volume of the beam will then be a minimum, and by adopting this shape for the solution of the initial (simple) problem—see Part I—our task is at an end.

Solution 3.—The problem requires that the width vary in a determined manner. Let us assume that the widths of the flanges and web taper in the same and direct manner from B at the point of support to $\frac{B}{3} = B_0$ at the loaded end, or in the ratio of 3 to 1. For any length x the width B_1 will be:

$$B_1 = (B - B_0)\frac{x}{L} + B_0 \qquad (38)$$

The contour lines of the widths being straight, no calculations are necessary for delineating; but to obtain the hights at various points equation (38) must be used —somewhat transformed—as we will see presently.

From equation (37) we have:

$$\frac{B_1 H_1^2}{B H^2} = \frac{x}{L}$$

replacing B_1 by its value as above, and solving for H, we have:

$$H_1 = H\sqrt{\frac{B x}{(B - B_0)x + B_0 L}} \qquad (39)$$

Thus the dimensions of the upper flange for $x = \frac{3}{4}L$, would be:

$$B_1 = (B - B_0)\frac{x}{L} + B_0$$
$$B_1 = \left(10 - \frac{10}{3}\right)\times\frac{3}{4} + \frac{10}{3} = 8\tfrac{1}{3}''$$

$x = L$					$x = \frac{3}{4}L$				
No.	B	H	R	I	No.	B	H	R	I
1	10″	2″	7¾″	1246.976	1	10″	1.732	6.82	809.934
2	2″	6⅞″	3 7/16″	216.634	2	2″	5.954	2.977	140.384
top total		8⅞″		1463.61			7.686		950.318
3	2″	9⅛″	4 9/16″	306.573	3	2″	7.902	3.951	329.063
4	6″	2″	10⅛″	1234.19	4	6″	1.732	8.568	801.63
bott. total		11⅛″		1740.723			9.634		1130.633
$\frac{I}{a}$ required, top $= \frac{I}{a}\times\frac{x}{L} =$				164.91					123.69
$\frac{I}{a}$ calculated $= \frac{I_1 + I_2}{H_1 + H_2} =$				164.91					123.69
$\frac{I}{a}$ required bott. $= \frac{I}{a}\times\frac{x}{L} =$				156.47					117.35
$\frac{I}{a}$ calculated $= \frac{I_3 + I_4}{H_3 + H_4} =$				156.47					117.35

$x = \frac{1}{2}L$					$x = \frac{1}{4}L$				
No.	B	H	R	I	No.	B	H	R	I
1	10″	1.414	5.568	440.9	1	10″	1″	3 15/16″	155.872
2	2″	4.861	2.43	76.592	2	2″	3 7/16″	1 23/32″	27.079
top total		6.275		517.492			4 7/16″		182.951
3	2″	6.452	3.226	179.086	3	2″	4 9/16″	2 9/32″	63.816
4	6″	1.414	7.150	436.352	4	6″	1″	5 1/16″	154.38
bottom total		7.866		615.438			5 5/16″		217.596
$\frac{I}{a}$ required, top $= \frac{I}{a}\times\frac{x}{L} =$				82.46					41.23
$\frac{I}{a}$ calculated $= \frac{I_1 + I_2}{H_1 + H_2} =$				82.46					41.23
$\frac{I}{a}$ required bott. $= \frac{I}{a}\times\frac{x}{L} =$				78.23					39.12
$\frac{I}{a}$ calculated $= \frac{I_3 + I_4}{H_3 + H_4} =$				78.23					39.12

American Machinist

Tables of transverse sections
Example II Case 1.

$$H_1 = 2\sqrt{\frac{10 \times 0.75\,L}{\left(10 - \frac{10}{3}\right) \times \frac{3}{4}L + \frac{10}{3}L}} = 1.897''$$

The other dimensions can be obtained just as easily as this one, and it is unnessary to proceed further, for the method is too simple to need additional proof of its correctness.

If the widths were made to vary in a different manner, it would suffice to introduce in formula (37) the equation of the variation of the width—whatever it might be—and to solve for H_1, as we have done.

Graphical processes may be used with advantage instead of calculations, and much time can be saved thereby.

We can easily see now that all the shapes convenient for beams of uniform strength and of rectangular section are also suitable for beams having complex sections, *provided all the parts of the sections be treated in the same manner throughout the beam.*

In concluding this long series of articles the writer believes that the solution of the *simple problem* is as complete in its elementary form as up-to-date knowledge can make it. But, after all, the problem was only used as a pretext to show the necessity of making conscientious investigations in order to increase our knowledge of the laws governing the resistance of materials.

(Concluded.)

Compulsory Arbitration in Australia.

Whatever may be said of the merits or demerits of the compulsory arbitration law of New Zealand it seems to have sufficiently commended itself to the sister colony of New South Wales as it is following the example, in a slightly modified form, however. A Sydney correspondent of the New York "Times" says:

In framing the act several improvements, suggested by the working of the law in New Zealand, have been made. In New Zealand any seven persons can form an industrial union, but in New South Wales only a registered trades union can do so. The reason for the change is that the privilege given in New Zealand was abused, and has been sometimes used by manufacturers to arouse disputes in the factories of trade rivals. Moreover, it is enacted that no industrial dispute can be referred to the court of arbitration save by a registered trades union or by the official Registrar, and it is also imperative that the opinion of a majority of the members of the trade shall be taken in a manner prescribed. This is for precautionary purposes, so that there shall be no hasty or ill-considered entrance into a dispute.

Again, there are no boards of conciliation, as in New Zealand. This means that there will be no preliminary investigations, the dispute being taken straight into court, thereby preventing delay and decreasing expense. Another and most important innovation consists in making it a misdemeanor by employees to strike, or by employers to lock out, either before a reference or during its progress. There is to be no cessation of industrial operations pending the settlement of the dispute.

It is stated that this is the first instance of an attempt being made in any legislature to treat a quarrel between a master and his workmen as a public nuisance which ought to be prohibited, just as any brawl in a public place. There is also an improved method of enforcing the decisions of the court.

The act empowers legal arrangements to be made for the supply of labor with associations of workmen. These arrangements can be enforced like any other contract, either by a penalty named in the contract itself, or by the recovery of damages against the funds of the union, by suit brought in the Arbitration Court. The funds of a trade union are, however, protected against any liability except under this act. The court is to be composed of a judge of the supreme court, as president, and two members, one elected from among the employers and one by the employees. The method of electing these members is prescribed, and every care has been taken to make the court an independent tribunal; it has large powers, and there is no appeal from its decision. Every industrial dispute can be referred to the court, either by an industrial union or by the Registrar of the court.

The orders of the court may be enforced, as in New Zealand, by injunction, or by fines and penalties, levied both on the corporate funds of the union and on individual members; but they are also enforceable by another method, upon the efficiency of which will probably depend the success or failure of the act—the declaration of a common rule. Briefly put, the common rule enactment gives the court power to declare that any practice, usage, etc., shall, with such limitations and exceptions as the court shall specify, become a common rule for all persons employed in the particular industry under review. When once it is declared it must be obeyed just as a regulation under the Factories acts, the inspectors under which will be intrusted with its enforcement. It will be open to any person aggrieved to apply to the court to be excluded from the common rule, and the court has full power to at any time vary its own orders.

B. R. Wise, State Attorney-General, who is author of the act, believes that there will be a great extension of trades unionism and of combination among employers. The tendency will be more and more for large bodies of workmen to make bargains with large bodies of employers. The general result, Mr. Wise affirms, will be to give greater stability to industry. Employers need no longer be afraid that their calculations will be upset by a sudden cessation of work, because, though disputes may arise, work must go on while the dispute is being settled by the court. Contractors will also be able to make bargains with the trades unions for wages to be paid during the progress of any work, and these bargains can be legally enforced like any other contract.

On the other hand, the workman is in a position of greater security, both because he knows he cannot be locked out and because the court, in the exercise of its powers, can take cognizance of any abuse or injustice in the condition of his employment, and by the exercise of its power to declare a common rule level up the conditions of employment in every industry to those which prevail in the best-conducted establishments. Thus sweating ought to become a thing of the past. Trades unions will also be relieved from the danger of having their funds frittered away in what is called a "sympathy" strike. In the past the wealthy unions have often had to support the weaker unions and have been driven into strikes when they themselves have had no dispute with their employers.

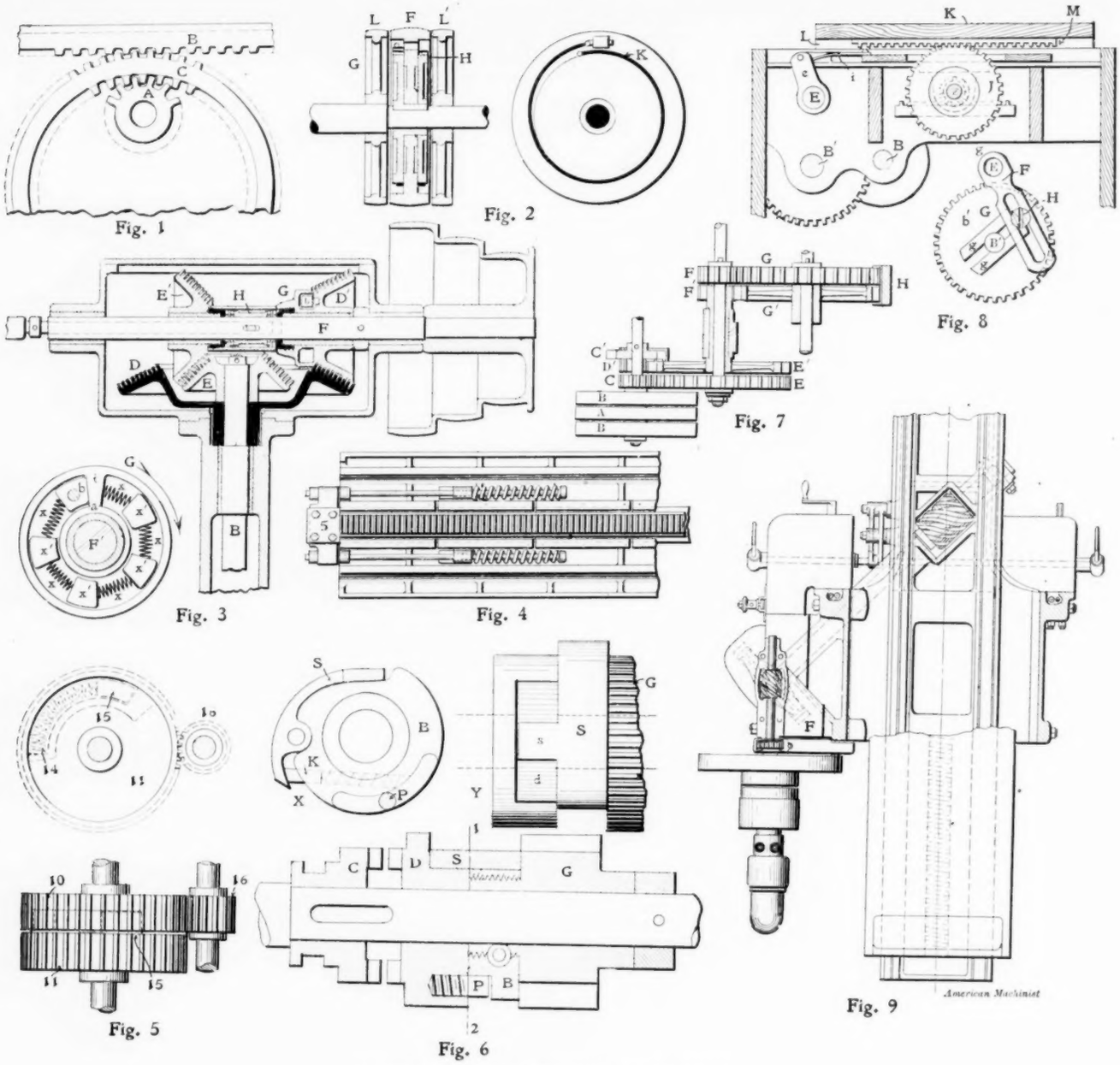
Some Inventions in Planer Driving and Reversing Mechanisms.

BY HOWARD A. COOMBS.

A number of devices have been invented for securing the smooth running of planers and for avoiding injurious shocks at the ends of the stroke. I propose to describe a few such devices, and have drawn not only from American sources, but from England and Germany as well. This is in no way intended to be a comprehensive showing of the art, but is rather a culling here and there in the great field of invention of a few of the products of mechanical ingenuity.

It is interesting to note that it is not only in these days of high pressure, rush and fierce competition that designers of planing machines have sought to eliminate or reduce the loss of time incurred by the idle return stroke of the table. Planers which date back to the thirties either reversed the tool so that it would cut on both strokes or used two tools. The quick return idea also is an old one—how old I do not know, but certainly as old as 1837.

When dealing with large planers the introduction of the quick return involves another problem—that of absorbing the momentum and overcoming the inertia of the moving parts in a short period of time. To obviate the disadvantages of a small pinion without increasing its diameter is the object of the curious construction shown in Fig. 1, patented by George Wilkinson in England in 1884. Between the pinion *A* and the rack *B* he interposes the internal and external gear C, which of course can be made as large as space will permit, thus obtaining the advantages incident to the use of a large driving gear and the shaft speed resulting from the use of a small gear.



PLANER DRIVING AND REVERSING MECHANISMS.

To avoid the usual consequences of a sudden reversal of a rapidly moving table, such as undue stress upon the teeth of the gears or other driving parts, slipping and the resultant squeaking of the belts, etc., it is not uncommon to interpose somewhere a yielding connection, preferably a spring, which does not entail the loss of power incident to the use of a friction clutch, and which returns the energy expended in compressing or extending it. One adaptation of the idea is illustrated in Fig. 2 from an 1890 British patent to Mr. F. W. Smith, of the well-known firm of Smith & Coventry, of Manchester. The driving pulley *F*, which I shall paradoxically term the "fast" pulley, is not keyed to the shaft, but communicates power thereto through two disks *G* and *H*, which are keyed to the shaft, and two springs *K*, which pass around the peripheries of the disks. One end of each spring is attached to the fast pulley near the rim and the other end is fastened to the disk. When either the straight belt or the crossed belt is shifted on to the fast pulley from the loose pulleys *L* or *L'*, one of the springs is tightened or wound up on one of the disks, which, by the way, lie, as shown, wholly within the edge of the fast pulley, while the other spring is loosened or backed off the periphery of the other disk.

Another adaptation of the yielding connection is shown in Fig. 3 from the United States patent to C. Van Haagen, of Philadelphia, May 30, 1876. The return or quick drive is positive through shaft *F*, bevel wheels *E'* and *E*, which may be gears or friction wheels, as shown, to shaft *B*, which drives the platen. When, however, the clutch *H* is shifted to the right to actuate the forward or slow drive, it does not engage directly with the bevel wheel *D'*, which drives the large gear *D*, but with the disk or wheel *G*, between which and the bevel wheel *D'* is the yielding connection shown in detail below at the left. Wheel *D'* carries a pin *b* which projects into an annular recess in *G*, the recess being interrupted in one place only by the integral spoke *i*. Between one side of this spoke *i* and one side of the pin *b* are arranged a series of coiled springs *x* separated by sliding blocks *x'*. When *G* is clutched to shaft *F* and starts to rotate in the direction of the arrow, each of the springs *x* will be compressed before *D'* accompanies *G* in its rotation. As soon as *G* is unclutched and *D'* is rotated in the other direction, the springs expand and bring spoke *i* snugly up against pin *b*.

A recent United States patent to two Englishmen, R. W. and L. H. Bateman, of Halifax, Yorkshire, shows two adaptations of the spring connection—one, shown

in Fig. 4, involving a relative movement between the rack and the platen, and the other, in Fig. 5, a relative movement between two gears. In the former construction the rack is mounted to slide in a groove in the table, and carries at one end a crosshead 5, to which are connected the two long rods having heads on their inner ends, between which and bearings under the table are placed spiral springs. When the rack is driven to the right it carries the platen positively along with it, but when the direction of motion is changed the compression of the springs takes up any shock which a positive connection would probably entail.

The second arrangement needs but little description, 11 being the rack-driving gear and pinion 16 the source of power, meshing with gear 10, which is fast on the pressed plunger K located in the part B tends to keep the projection s down on the flattened part of D and a pin P limits the relative movement of D and B. When the "fast" clutch member C is engaged with D, the projection of the spring S is raised, and when the resistance of said spring equals the force opposing the rotation of gear G the latter turns as one with the clutch members and shaft.

Mr. Hugo Bilgram, of Philadelphia, whose bevel-gear planers and other inventions are well known to the readers of the "American Machinist," in a planer patent, December 4, 1883, shows how the evil of back-lash can be avoided in a rack-driven planer, using only a single belt. Referring to Fig. 7, A is the loose pulley, and when the belt is shifted on to B or B' the power is transmitted to the rack H either through This gear carries an adjustable crank pin, and this, by means of slotted arm F, oscillates shaft E, which has a crank arm e connected by a pitman i to the slide I. The slide I supports in a dependent bracket a transverse shaft carrying two pinions, which mesh with stationary racks in the frame, and a large gear wheel J which projects through a slot in the slide I and meshes with the rack on the table. If the circumference of the gear J is five times that of the pinions, then the work table K will travel five times as far as the slide I. This machine combines the accuracy and regularity of length of stroke which is the desirable feature of crank planers, with the capacity for large work of the rack-driven machines.

What is known, I think, as the Sellers driving gear may be familiar to many. It

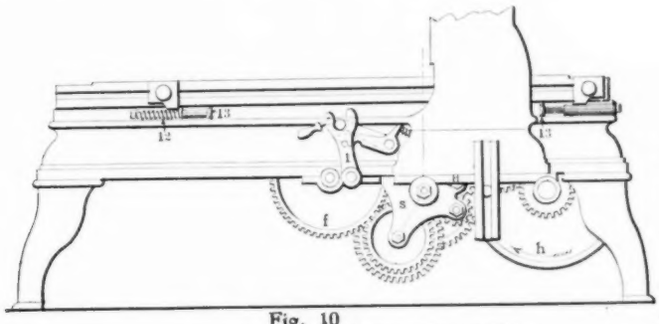


Fig. 10

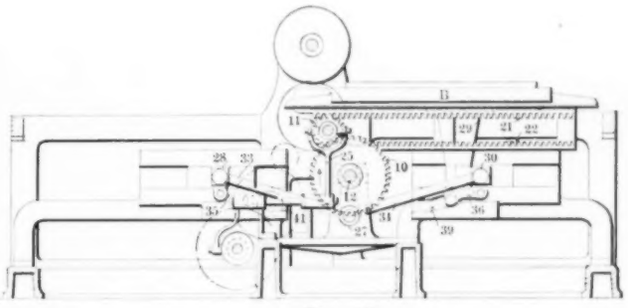


Fig. 12

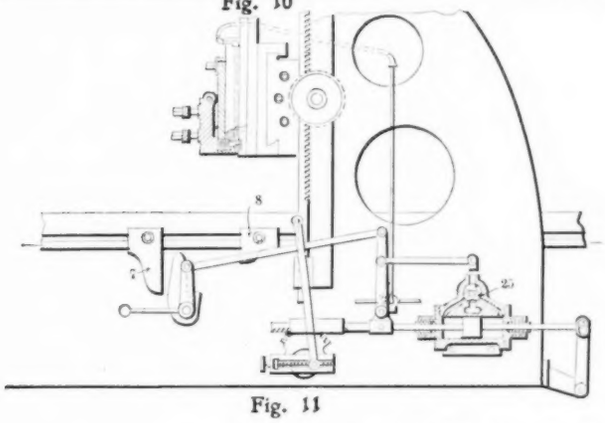


Fig. 11

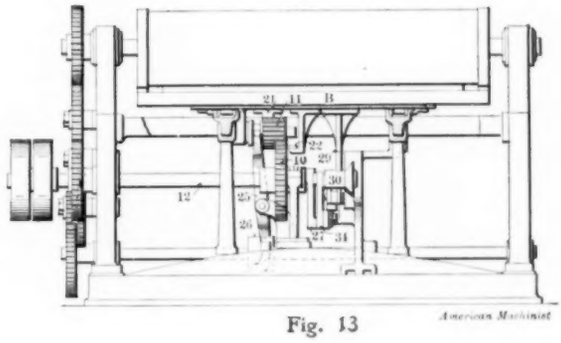


Fig. 13

PLANER DRIVING AND REVERSING MECHANISMS.

shaft and which is connected to gear 11, which of course is loose on the shaft, by projection 15 and spring 14, shown in dotted lines.

What is, apparently, a peculiar incorporation of the same idea is the subject of a German patent to Herr Haas, No. 39771, dating from 1886, and shown in Fig. 6, X being a section on line 1—2 and Y a partial plan of the same view. Instead of clutching the rack-driving pinion G, or "bull-gear," as it is sometimes called, directly to its shaft, the connection is made through clutch member D, spring S and member B, which last is screwed on to the hub of the gear G. The spring S, which is of considerable thickness and is consequently very stiff, is pivoted to B and has a projection s on one side which lies on a flattened portion d of clutch member D. A spring-

C, E, F and G or through C', D', E', F' and G', D' being an intermediate gear between gears C' and E', so as drive E' in the reverse direction. When one of these trains of gearing is driving the rack, the other is being driven by the rack; consequently, the teeth of the gears G and G' are always kept in engagement with that side of the rack teeth which they engage when driving and no reversal of contact takes place. It will be noticed that one of these trains drives the rack at a higher speed than the other.

I want to describe next an ingenious combination of the rack and crank types of planer shown in Fig. 8, which was the invention of William H. Warren, of Worcester, Mass., over thirty years ago. B is the driving shaft carrying a pinion which meshes with a gear on shaft B'.

accomplishes a smooth drive by the use of helical pinions meshing with the rack and the spur gear respectively, as shown in Fig. 9, and attains reversal of the table motion without shock by the use of a double friction clutch, which is so actuated that it operates as a brake before it acts as a clutch. This statement, I fear, is broad enough to be true in every case where there is a double friction clutch; but in this case the clutch, when acting as a brake, is held by spring pressure of less degree than that subsequently applied for driving. The tappets on the table actuate the mechanism by which the clutch is withdrawn only, other means being provided for engaging it with the reverse pulley. As this means can be thrown in or out of operation at will, it results that the table can be stopped at the end of any

stroke without throwing off the power or altering the position of the tappets. There are some other interesting features in this machine which I will not attempt to describe here. The machine itself can be found in many shops.

In the machine patented in this country by O. R. Chaplin, of Boston, July 30, 1878, the tappets on the table are provided with spring bolts (see Fig. 10), and the shipping lever controls a rocking plate *s*, which supports the train of gears connecting the driving pulley *h* and the rack-driving gear *f*, so arranged that in one position of the rocking plate the train drives gear *f* in one direction and in the other extreme position it drives it in the other direction, there being naturally an intermediate neutral position. The rocking plate is held by latches in its various positions. The operation is as follows: When the bolt 13 strikes the lever 1 the spring 12 is compressed until the head of the bolt brings up against the end of the spring socket, when the latch which holds the shipping lever is forced out, and then the spring expanding throws the lever over to its other extreme position, thereby changing the direction of rotation of driving gear *f*, and consequently the direction of motion of the table—provided the teeth of one or more of the gears are not stripped off. Throwing out of mesh a gear driving *f* in one direction and instantly throwing in another to drive it in the opposite direction would seem to demand an unusual degree of strength in the teeth, and I should think it would be advisable to incorporate into the train one of the yielding devices described above.

Mr. C. R. Gabriel's interesting mechanism for gradually starting and stopping a rotary member, such as a gear, and driving it a constant speed during the interval needs no further description from me, as it was fully written up in the "American Machinist" for May 17, 1900. The platen of the machine illustrated in Fig. 11 is not depended upon to do the actual work of shifting the belts or throwing the clutch, compressed air being employed for that purpose, all the table has to do being to actuate the valve 25 by means of dogs 7 and 8. In addition to the main valve and cylinder, there is a small valve which is actuated by a pin on one of the shifting levers, which valve admits air to a little cylinder in the tool slide, the piston of which operates to lift or clear the tool on the back stroke. The illustration is from a recent United States patent to Mr. R. Gordon, of England.

In conclusion, I wish to describe a mechanism which, although in the patent not shown as applied to a planer, is perfectly applicable to such use, and which, moreover, shows how the difficulty of starting and stopping a reciprocating part has been met in an art which requires far higher speeds than those of machine tools. I refer to printing presses, and to those of the bed and cylinder type, and I have chosen the machine patented by Mr. L. C. Crowell in June, 1892, and assigned to the Hoe Printing Press Company, as a typical illustration.

The traveling bed *B* (see Figs. 12 and 13) carries an upper rack 21 and a lower rack 22, with which the driving pinion 11 alternately engages, it being moved laterally by the cam-operated lever 25. Before the end of the stroke is reached the pinion runs out of the rack and other means are employed to gradually stop and then start the bed in the other direction. Advantage is taken of the perfect adaptability for that purpose of the alternate reciprocatory motion which is obtained from a crank, similar in all respects to that of the cross-head of an ordinary steam engine. From the bed B depends an arm 29, alternately engaged on one side or the other by lugs carried by the sliding cross-heads 28 and 30. These cross-heads are reciprocated by connecting rods 33 and 34 from a crank 27 on the end of the driving shaft 12, on which shaft is also the gear 10 which drives the rack-engaging pinion 11. The cam 26 which shifts the pinion 11 laterally to engage one rack or the other is also driven from the same source of power. The movements of the parts are so timed in relation to each other that the maximum speed of the cross-heads equals the speed of the table or bed *B*, and that the lugs on the cross-heads will come into contact with and pass out of contact with the arm 29 at the moment of their maximum speed. The operation is then as follows: Just before the rack runs off the pinion the arm 29 contacts with one of the cross-heads, then traveling at the same speed. As the crank moves around from a position at right angles to the path of travel of the cross-head to one in line with said path, the cross-head, and with it the arm 29 and bed *B*, are progressively, or, rather, retrogressively, brought to rest, and during the travel of the crank through the succeeding arc of 90 degrees, it is started in the opposite direction and gradually brought up to its normal speed, the pinion 11, which has meanwhile been moved over in position to engage the other rack, taking hold just as the crank reaches its vertical position. To prevent "jump" latches may be provided to hold arm 29 snugly against the lugs on the cross-heads, said lugs being shown at 35 and 36 and being automatically operated by cams 39 and 41. The operation of this beautiful piece of mechanism recalls the actions of a ball player when he has to stop a "hot one"; his hands outstretched to receive the "hurtling sphere," commence a retrograde movement just before the impact, and continue it with gradually diminishing velocity until the *vis viva* (or *viva voce*, as old Bill Jones used to say) of the ball has been completely overcome.

A ton of cotton seed yields about 750 pounds of meal, 950 of hulls, 25 of linten and 37 gallons of oil.

Experiments on Spiral Springs.*

BY CHAS. H. BENJAMIN AND ROY A. FRENCH.

The experiments described in the following paper were made under the direction of Mr. French, and the calculations are his. There is such scarcity of reliable data on spiral springs, their strength and elasticity, that it seems desirable to publish the results of these experiments.

Our text-books and our technical journals contain discussions and formulas, but very few data from which constants can be obtained to use in the formulas.

In the experiments to be described, an attempt has been made to determine the coefficient of torsional elasticity and the safe stress for different sizes of bar and different ratios of mean diameter of spring to diameter of bar.

The following notation will be used:

P = load in pounds.
S = torsional stress in pounds per square inch.
G = coefficient of torsional elasticity.
D = mean diameter of spring in inches.
d = diameter of bar in inches.
H = hight of spring in inches.
L = length of bar in inches.
x = deflection in inches with load P.

Then, by the usual formulas for tension and compression springs:

$$P = \frac{S\,d^3}{2.55\,D} \text{ and } x = \frac{L\,D\,S}{G\,d}.$$

The springs tested were all made of tempered steel and were open-coil, or compression springs. The results shown in the table were in every case obtained by testing a number of springs made as nearly alike as possible, and using the average loads and deflections for computation.

Every spring was first closed solid, coil to coil, several times in a hydraulic press, to remove all permanent set; then placed in a Riehlé testing machine and tested for capacity and corresponding deflection.

To illustrate, take for an example group No. 1 in the table. This group consisted of fifteen springs, 9.25 inches outside diameter and 17.25 inches free hight before closing. The steel used was 1.3125 inches in diameter and 150 inches long before the ends were tapered. These springs were placed in the press one at a time and closed coil to coil twice under the full capacity of the press, 75,000 pounds. The pressure was then removed, and upon measuring they were found to average 15.25 inches in hight, showing a set of 2 inches. They were then closed twice more, but took no further set. A spring closed solid with 100 per cent. overload should take all its permanent set with two closings.

The springs were then placed in the testing machine and the load and total deflection measured. The average load necessary to close them was found to be 10,900 pounds, and the corresponding de-

*A paper presented at the New York meeting of the American Society of Mechanical Engineers.

flection was 7.0625 inches. When taken from this machine the free hight was again measured, but they had taken no more set.

For substitution in the formulas we then have:

$P = 10.900.$
$d = 1.3125.$
$D = 9.25 - d = 7.9375.$
$x = 7.0625.$
$L = 150.$

Substituting and solving for S and G: S = 97,500 = the torsional stress in pounds per square inch when the spring is closed coil to coil, and G = 12,500,000, the coefficient of elasticity. Dividing the mean diameter of the spring by the diameter of the bar gives a ratio which will be called R, in this case equal to 6.05. Dividing the permanent set by the working deflection gives another ratio, which will be called Y. In this case, Y = .283.

Group.	Number of Springs.	Outside Diameter.	Mean Diameter.	Diameter of Bar.	Ratio = $\frac{D}{d}$	Length of Bar.	Height before Closing.	Height after Closing.	Permanent Set = $H - H'$.	Height when Closed.	Total Action = $H' - H''$.	Ratio = $\frac{S}{x}$	Load to Close Spring.	Coefficient of Torsional Elasticity	Torsional or Shearing Stress.
	N	O	D	d	R	L	H	H'	S	H''	x	Y	P	G	S
1	15	9.25	7.9375	1.3125	6.05	150	17.25	15.25	2	8.8175	6.432	.311	10,900	12,500,000	97,500
2	20	6.625	5.375	1.25	4.3	80	7.125	7	.125	5.9375	1.062	.117	6,375	14,400,000	44,700
3	12	6	4.75	1.25	3.8	67	7.875	7.5	.375	5.875	1.625	.23	16,600	16,150,000	103,000
4	6	5.25	4.125	1.125	3.67	89	10.75	10.125	.625	7.625	2.5	.25	13,800	13,400,000	102,000
5	20	4.75	3.625	1.125	3.23	75	9.875	9.375	.5	7.25	2.125	.235	17,000	12,500,000	110,000
6	40	7.75	6.625	1.125	5.9	100	7.875	7.625	.25	5.5	2.125	.117	4,850	15,800,000	57,500
7	36	5	3.9375	1.0625	3.7	61	7.5	6.9375	.562	5.375	1.562	.36	12,000	14,400,000	100,000
8	64	5.5	4.4375	1.0625	4.18	101	11.125	10.6875	.437	7.625	3.062	.142	12,000	15,100,000	113,000
9	24	4.375	3.3125	1.0625	3.1	48	6.5	6.125	.375	5	1.125	.333	14,800	13,700,000	104,000
10	6	6	5	1	5	84	8.625	8.125	.5	5.625	2.5	.2	8,000	17,100,000	102,000
11	20	4.5	3.5	1	3.5	79	9.875	9.4375	.437	7.25	2.187	.201	12,500	14,100,000	111,800
12	16	4.25	3.25	1	3.25	49	6.5	6.125	.375	4.875	1.25	.3	13,100	13,800,000	109,000
13	36	4.75	3.75	1	3.75	37	4.5	4.125	.375	3.25	.875	.43	12,000	18,100,000	114,400
14	35	4.187	3.25	.9375	3.48	50	6.5	6	.5	4.75	1.25	.40	10,500	14,700,000	106,000
15	800	4.5	3.625	.875	4.15	57	6.375	6	.375	4.4375	1.562	.24	6,250	13,100,000	86,500
16	8	3.75	2.875	.875	3.28	41	5.375	5	.375	4.125	1.875	.43	10,800	18,100,000	118,000
17	24	4	3.125	.875	3.58	60	7.375	7	.375	5.4375	1.562	.24	8,650	13,500,000	103,000
18	40	4	3.125	.875	3.58	51	6.5	6	.5	4.625	1.375	.364	12,000	18,900,000	143,000
19	24	3.375	2.625	.75	3.5	62	7.25	7	.25	5.655	1.345	.186	5,250	13,500,000	83,500
20	8	5.75	5	.75	6.67	172	17.625	16	1.625	8.4375	7.562	.212	2,850	13,100,000	86,500
21	8	4.5	3.75	.75	5	84	8.5	8	.5	5.5	2.5	.20	4,000	15,200,000	91,000
22	12	3.5	2.75	.75	3.67	53	6.375	6	.375	4.625	1.375	.273	6,950	16,200,000	115,000
23	4	4	3.25	.75	4.33	44.5	5.75	4.6875	1.0625	3.0625	1.625	.655	6,500	15,400,000	127,400
24	24	3.5	2.875	.625	4.6	68	7.375	7	.375	4.6875	2.312	.162	3,250	13,600,000	97,500
25	100	3.25	2.625	.625	4.2	37.5	4.375	4	.375	2.8125	1.187	.316	4,225	15,500,000	116,500
26	100	3.25	2.625	.625	4.2	43	4.75	4.5625	.187	3.375	1.187	.158	4,000	16,500,000	109,500
27	200	3.5	3	.5	6	108	9.75	9.625	.125	5.8125	3.812	.032	1,250	12,900,000	76,500

TABLE OF RESULTS OF TESTS WITH SPIRAL SPRINGS.

In a similar manner were calculated all the results given in the table.

Additional notation used in table:

N = number of springs in group.
O = outside diameter in inches.
H = hight before closing in inches.
H' = free hight in inches after producing set.
H'' = hight in inches when closed solid.
$s = H - H'$ = permanent set in inches.
$x = H' - H''$ = total action in inches.

The value given for G in most hand books is 12,000,000. The larger values shown in the tables are doubtless due to the higher grade of steel used. The variation in values of G is probably due to differences in temper, although in some cases the chemical constituents of the steel may have varied slightly. The average value is found to be 14,700,000, which may be written 14,500,000 for convenience.

The proper stress is a more difficult thing to determine. A wide range of stresses was used in the springs experimented with. In each case the stress was that believed to be the best for the conditions under which the spring must work.

In some few cases, as in No. 18, it was necessary to use an abnormally high value to meet the conditions. This necessitated a special grade of steel, and great care in manufacture. Such a spring is not safe when subjected to sudden and heavy loads, or to rapid vibrations, as it would soon break under such treatment; if merely subjected to normal stress, it would last for years.

It will be noticed, by comparing columns S, Y and R of the table, that Y varies with both S and R for the same diameter of bar; that is, if R is constant, S and Y increase together, and if S is constant, R and Y increase together. There are some exceptions to this rule noted, but it is believed to be generally correct. This being true, a spring with its mean diameter small, as compared with size of bar, will allow a higher stress with less proportionate set than one of a larger mean diameter. An excessive set means injury to the material an liability of failure.

Springs of a small diameter may safely be subjected to a higher stress than those of a larger diameter, the size of bar being the same. The safe variation of S with R cannot yet be stated.

There is an important limit which should be here mentioned. Springs having too small a diameter as compared with size of bar are subjected to so much internal stress in coiling as to weaken the steel. A spring, to give good service, should never have R less than 3.

The size of bar has much to do with the safe value of S; the probable explanation is this: A large bar has to be heated to a higher temperature in working it, and in high carbon steel this may cause deterioration; when tempered, the bath does not affect it so uniformly, as may be seen by examining the fracture of a large bar.

The above facts must always be taken into consideration in designing a spring, whatever the grade of steel used. A safe value of S can be determined only by one having an accurate knowledge of the physical characteristics of the steel, the proportions of the spring and the conditions of use.

For a good grade of steel the following values of S have been found safe under ordinary conditions of service, the value of G being taken as 14,500,000.

For bars below ⅜ inch diameter:

$R = 3$ $S = 112{,}000$
$R = 8$ $S = 85{,}000$

For bars 7-16 to ¾ inch in diameter:

$R = 3$ $S = 110{,}000$
$R = 8$ $S = 80{,}000$

For bars from 13-16 to 1¼ inches in diameter:

$R = 3$ $S = 105{,}000$
$R = 8$ $S = 75{,}000$

For bars over 1¼ inches in diameter a stress of more than 100,000 should not be used. Where a spring is subjected to suden shocks a smaller value of S is necessary.

As has been noted, the springs referred to in this paper were all compression springs. Experience has shown that in close coil or extension springs the value of G is the same, but that the safe value of S is only about two-thirds that for a compression spring of the same dimensions.

[In our report of the New York meeting, at page 1386, 1901, will be found the substance of Mr. Cary's remarks on this paper. He considered the 3-diameter springs endorsed in the paper too small, 5 diameters being, in his opinion, the desirable minimum and 7 to 9 diameters the best proportion. He also regarded tests on the spring wire as more desirable than on completed springs, as the observed values of G were much less discordant. He also considered that, while spring formulas were applicable to springs wound in the soft state and then tempered, they were not applicable to those wound from wire which was already tempered, because of internal stresses due to the coiling.—Ed.]

Two Drill Jigs — Sensitive Drill — Leather Tip Perforating Machine.

BY JOSEPH V. WOODWORTH.

In Fig. 1 is shown a drill jig embodying a number of practical ideas. This jig is for spacing off and centering holes or punch seats in small wheels which are in turn used when supplied with punches for perforating leather shoe tips and miscellaneous service of that character. The wheel

before drilling is shown in a cross section at *W*, Fig. 3, and as finished with all holes drilled and counterbored and the punches inserted at *H*, Fig. 4, in which is shown

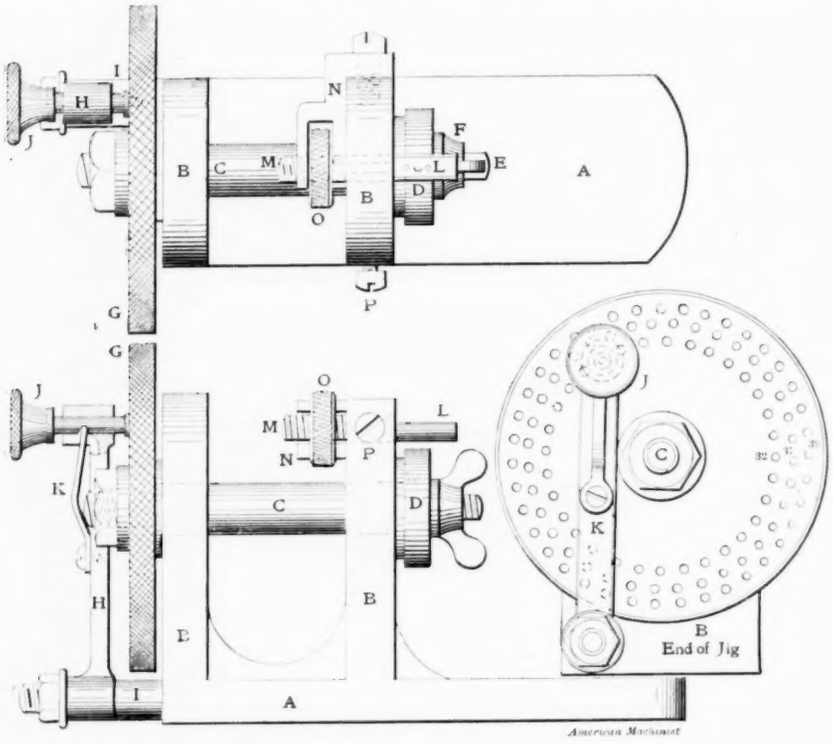


FIG. 1. DRILL JIG FOR SPOTTING PERFORATING WHEELS.

the machine on which the wheels are used. These wheels are of cold-rolled machine steel and are finished all over in the turret lathe.

As the holes or seats for the perforating punches are usually very small, it is not possible to drill them to the required degree of accuracy in one jig; so two jigs were used—one for spacing, locating and centering the holes, and the other for drilling and counterboring them. The jig for spacing and centering the holes is shown in Fig. 1 and the jig for drilling and counterboring in Fig. 3.

The spacing and centering jig, Fig. 1, consists of a flat-bottomed casting *A* with two standards *B B* which support the indexing device. There is a shaft *C* with a wide shoulder at the front end to rest against the face of the standard, and an end projecting from this shoulder to fit the hole in the wheel and threaded for the nut *F*. A small pin in the face of the shoulder locates the wheel in position on the spindle. The index plate *G* has three circles of holes, the numbers of the holes being designed for handling as large a variety of wheels as possible. The index pin *J* is located in a swinging arm *H* which swings on a stud let into a corner of the back standard *B*. A flat spring *K* is fastened to the arm with the end resting in a notch in the index pin. Instead of using bushings to guide the drills, a piece of 5-16 inch Stub's steel is used, it being finished with a flat at *L* with three holes for the drills. This end is hardened and the opposite end *M* is threaded for the adjusting nut *O* located in the fork of the bracket *N*. This adjustment allows of marking different combinations of holes in wheels of different thicknesses by the use of the one drill guide.

In conjunction with this drill jig the small sensitive drill press shown in Fig. 2 is used, and as the design and construction are clearly shown a detailed description is unnecessary. The manner of using the jig, Fig. 1, is as follows: A wheel *D* is located on the spindle, as shown, a drill is fastened within the chuck of the press, Fig. 2, and the table *A A* of the press is set so that it can be raised just high enough to center or spot the holes. The index pin *J* is then set for the required circle of holes by swinging and locating the arm *H*. After centering the first hole the next is located and centered by pulling out the index pin *J* with the left hand and rotating the index plate *G* with the right, the outside of the plate being knurled to facilitate it.

The jig for drilling and counterboring the wheels is shown in Fig. 3. It consists of a casting *Q* with a floating spindle *S* on which the wheels are placed to be drilled. This spindle is finished on the front end the same as the one used on the first jig, the work being located and fastened upon it in the same manner, the locating pin *U* entering the hole *V* in the wheel *W*. Two dowel pins are let into extreme corners of the bottom of the jig to coincide with two holes drilled in the table *A A* of the drill press, Fig. 2, so located that the center of the spindle *S* will be in line with the center of the drill chuck. By this means the holes can be drilled very rapidly and with the certainty that they will all point toward the common center. When drilling the wheels the spindle is rotated until one of the spotted centers is in line with the drill. The work is then pressed upward against

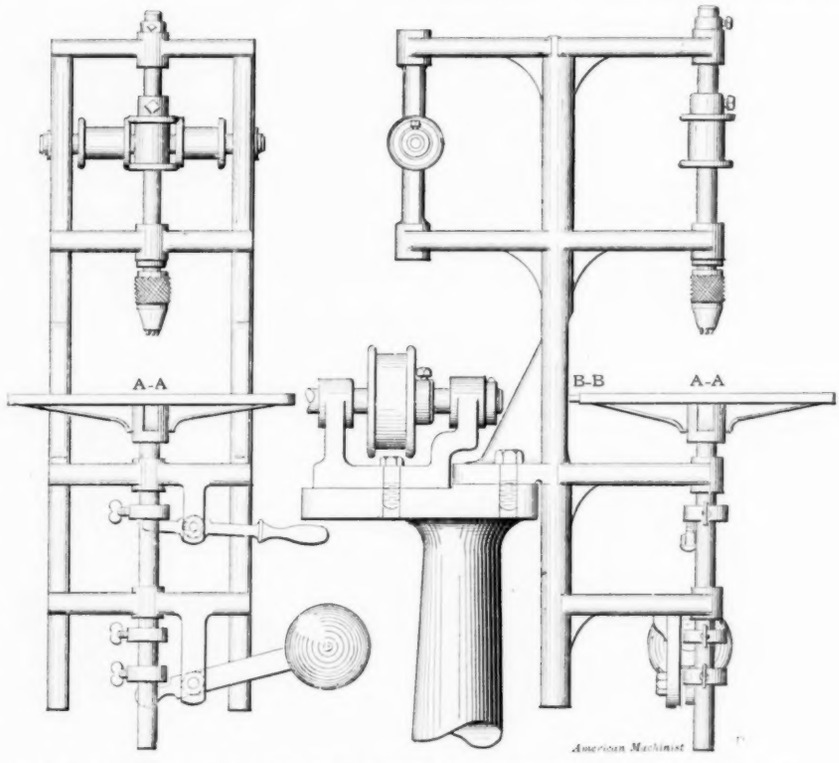


FIG. 2. SENSITIVE DRILL USED FOR DRILLING AND COUNTERBORING PUNCH HOLES IN PERFORATING WHEELS.

it and the drill instantly locates it perfectly in line.

The counterboring of the holes is accomplished in the same manner as the drilling, the counterbore being set to the required depth in the holes by means of the groove *X*, the table of the press being raised until the face of the counterbore rests on the flat face *Y* of the gage which is slipped into the spindle hole of the jig. The table is then set, the gage is removed, the work spindle *S* is re-inserted and the holes in the wheel are finished to the diameter and depth required.

The manner in which the wheels are used when finished is shown in Fig. 4. *H* is the wheel with all the punches inserted. *I* is the pinking cutter for pinking the edge of the work; *A* the body of the machine; *B* the cutter and disk spindle, which is rotated by hand by the crank handle *F*; *V* a hard rubber roller which runs free and can be adjusted on the yoke spindle *T* and raised or lowered by the knurled nut *O*. A sample of the work produced is shown at the lower right-hand corner of Fig. 3.

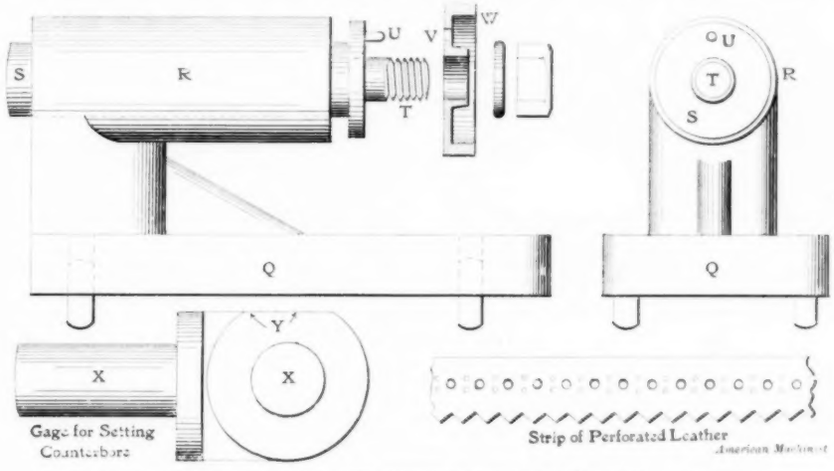


FIG. 3. JIG FOR DRILLING AND COUNTERBORING PERFORATING WHEELS.

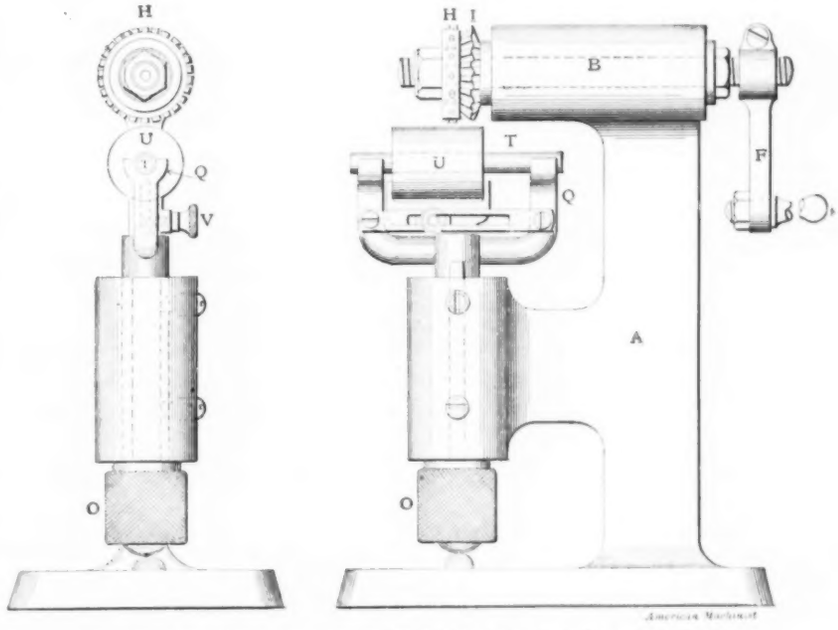


FIG. 4. MACHINE USED FOR PERFORATING AND PINKING LEATHER TIPS.

A Graphical Determination of the Efficiency of Spiral Gearing.

BY WALTER FERRIS.

In his excellent article on spiral gears, page 1337, Vol. 24, Mr. John Randol says: "Many persons are of the opinion that spiral gearing on 90-degree shafts wastes a great deal of power in friction, and that it is therefore much less efficient and durable than bevel gearing doing the same work. This view is wholly incorrect. The faces of all gear teeth—spur, bevel and spiral—rub hard against each other when doing hard work; the spiral tooth has the vast advantage of a much higher speed of the rubbing surfaces, and so will transmit the same load with much less crushing effect on the gear tooth faces, and hence runs the easier of the two and is the more durable, if both forms are well lubricated and perfectly enclosed against dust, as gears now not infrequently are and always should be."

While Mr. Randol's clear and practical presentation of the subject will facilitate the design and use of these gears where they are properly applicable, it seems to me that more should be said on the subject of their friction. Without claiming any wide experience in the use of spiral gears, I share the popular impression that they are wasteful of power and hence not well adapted to the transmission of heavy loads. For heavy transmission work the efficiency is even a more important consideration than smooth running or ease of construction. Efficiency is apt to be confused with such terms as "easy running," "smooth," etc., although really these things have no direct relation to efficiency, and in fact the smoothest running mechanisms are apt to be the least efficient. The self-sustaining screw or worm hoists are very easy running and very inefficient. We may get an approximate idea of the amount of this work expended in sliding friction by a little simple figuring, but a far easier and more accurate method is by a graphical construction. The graphical method of solving such problems as this is not, I believe, very familiar. It requires only a knowledge of the use of ordinary force diagrams, and is worthy of careful study by anyone who has felt the need of a method of finding the forces acting in an existing or proposed machine, taking account of friction. The method consists simply in laying down a scaled outline of the machine to be investigated, and using the known forces (such as steam pressure on an engine piston, or the weight lifted by a hoist) and known directions of pressure to find the unknown forces and directions of pressure by means of the usual triangles and polygons of forces employed in a peculiar manner. The principal special feature which gives the method a place apart from graphics in general is its ability to take account of those frictional forces which are called forth in every machine as a result of the action of the driving forces, and which change in intensity or direction with every change in the intensity or direction of the driving forces. Any analysis of a machine which fails to take account of friction is likely to be completely astray, not only inaccurate but absolutely wrong in its conclusions, and any attempt to follow analytically the course of friction in a mechanism is usually very laborious and only possible by frequent allowances and approximations which affect the result to an unknown extent. In short, no engineer thinks in practice of attempting to use the analytical method as an every-day means of testing his designs. On the other hand, few machines are so complicated as to require more than a half-day for a complete graphical analysis, and in most cases an hour or less is enough.

In order to eliminate questions of momentum and kinetic energy (which may be

accounted for in the higher development of machine graphics) the mechanism to be analyzed is supposed not to be in motion, but to be on the point of beginning to move, so that the slightest addition to the driving force would cause motion. In this case the driving forces are in exact equilibrium with the sum of all resistances, useful and "hurtful." The frictional forces, called forth by the various pressures of parts against each other, are in full action. In short, the machine is in exactly the same condition as when running, except that the absorption and giving out of energy by the moving masses whose velocities are not constant is not considered. This does not, in general, affect the efficiency of a machine, because all energy so absorbed is given out again without loss.

The basic proposition for our work may be thus stated: The effect of a frictional resistance may always be taken into account by a change in the direction or position of the force causing the friction, without considering, or even knowing, the magnitude of the forces involved.

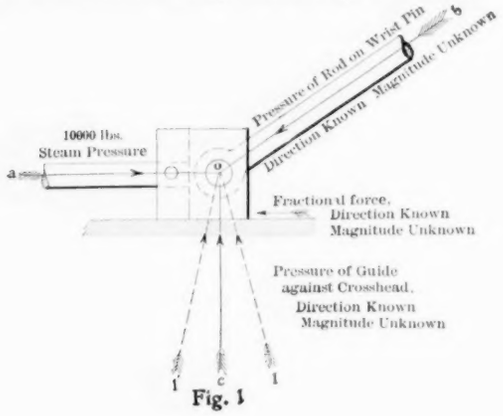


Fig. 1

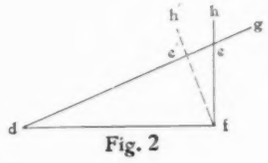


Fig. 2

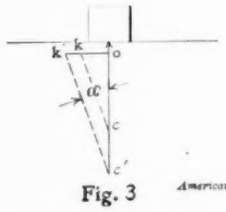


Fig. 3

GRAPHIC ANALYSIS OF FORCES ON A STEAM ENGINE CONNECTING ROD.

Let us first illustrate this point and then the importance of it will be apparent. Fig. 1 represents a steam-engine crosshead acted upon by a known steam pressure $a\,o$, a reaction $b\,o$ of the connecting rod and a reaction $c\,o$ of the guide. The problem is to find the true value of the force transmitted by the crosshead to the connecting rod, allowing for the effect of guide friction which diminishes the transmitted force. For the sake of simplicity, the friction of connecting rod on wrist pin is not considered.

If there were no friction the problem would be simple. Only three forces act on the crosshead, one of which is known in direction and magnitude and the others in direction. Lay off $d\,f$, Fig. 2, parallel to $a\,o$, Fig. 1, equal to 10,000 pounds by any convenient scale. From one end of $d\,f$ draw the indefinite line $d\,g$ parallel to $b\,o$, Fig. 1, and from the other end draw $f\,h$ parallel to $c\,o$, Fig. 1. These lines intersect at e, Fig. 2, and $d\,e$ and $f\,e$ to scale are the required magnitudes of the forces. Then the pressure $d\,e$ of the connecting rod against crosshead must also equal the pressure $e\,d$ of the connecting rod against the crank in the opposite direction.

We could pass on and next find the forces acting on the crank, and finally get the pull on the belt at flywheel rim, due to 10,000 pounds pressure of piston rod against crosshead. But we cannot do this, because friction modifies the reaction $c\,o$ of the guide and the reaction of all the other parts as well. The magnitude of the friction is a certain fraction of the guide reaction, but we do not know the magnitude of the guide reaction until the connecting rod reaction is known, which itself depends upon the friction that we are trying to find.

Now comes the important bearing of our proposition. We can find the *direction* of the guide reaction as modified by friction, because the friction is proportional to the vertical reaction, say, .05 or .10 of the vertical reaction, according to the coefficient of friction most applicable to the materials considered. Hence, in Fig. 3, the unknown vertical reaction may be $o\,c$, in which case the frictional force, parallel to the guide and opposing motion, is, say, $\frac{1}{10}\,o\,c = o\,k$, and the resultant of the two, the actual guide reaction is $c\,k$. Or the vertical reaction may be $o\,c'$, the frictional force $\frac{1}{10}\,o\,c' = o\,k'$, and the reresultant or true guide reaction $c'\,k'$. But in both suppositions, and in all possible cases, the resultants have the same direction, and that direction is given by the angle α, whose tangent is $\frac{o\,k}{o\,c}$, or the coefficient of friction, .05 or .10, or any other value that may be assumed. Now, we can lay off on Fig. 1 the true direction of the guide reaction $l\,o$ by making $l\,o\,c$ the angle whose tangent is the coefficient of friction, and by simply drawing $f\,h'$, Fig. 2, parallel to it we have in $f\,e'$ the true guide reaction and in $d\,e'$ the true connecting rod reaction.

It is important to remember that frictional forces always tend to oppose motion. For instance, in Fig. 1, the tangent of angle $l'\,o\,c$ is the same as that of $l\,o\,c$. But $l'\,o$ would tend to help the crosshead along, and is evidently wrong, and the other direction $l\,o$ is the actual direction of the guide reaction.

By similar lines of reasoning we should be able to establish a few simple rules which enable us to tell in every case what effect friction will have in changing the *direction* of any force which causes it; so that the direction and location of stresses in connecting rods, chains, belts, gear teeth, and all the other machine elements may be determined by simple inspection of the drawing. Beyond this, there is nothing radically different in the graphical analysis of a machine from that of a roof or bridge, and anyone who understands combining or resolving the two, three or four forces which may be acting on each part of a machine may readily grasp the method of accounting for friction by a little study, and by practice on actual machines.

Enough has been shown, however, to make it possible to find the efficiency of the pair of spiral gears described by Mr. Randol. These gears were both of 3 11-64 inches pitch diameter; the tooth angle of the driver was 13 degrees, and that of the driven gear was 77 degrees. I shall neglect journal friction, except the end thrust caused by the tooth pressure, and hence directly influencing the efficiency of spiral (*i. e.*, hyperboloidal) gears compared with other forms, which is the point under discussion. The driving gear tooth B, Fig. 4, is acted upon by three forces; a driving force $c\,k$, end thrust $e\,d$, and a tooth pressure $c\,h$. The first two combine to produce the last, and the more efficient the mechanism is the larger will be the tooth pressure transmitted to the driven gear.

On the supposition that the driver receives ¼ horse-power at 1,000 revolutions per minute and transmits this power to the driven gear from a 3 11-64 inch pitch circle, the driving force tangent to the driver's pitch circle is about 10 pounds. Let us represent it by the line $c\,k$, Figs. 4 and 5, acting on the point of tooth contact, and drawn to any convenient scale. The end thrust $e\,d$ lies in the center of the shaft, but it also is transferred to the tooth B through the shaft and the wheel web. If there were no friction the efficiency of the machine would be unity, and the resultant pressure of the tooth B against tooth A would be the largest possible. (Not possible, in fact, but ideal.) Its magnitude is easily found from the full lines of Fig. 5, where $k\,l$ (= 44.8 pounds) is the resultant of $c\,k$ and $c\,d$, Fig. 4. But in the actual running conditions the directions and consequently the magnitudes of both of these forces $e\,d$ and $c\,h$, Fig. 4, are modified by the frictional resistances which they them-

selves call forth. This causes the force $c\,h$ to take the direction $c\,i$ if the assumed friction coefficient is .05, or the direction $c\,j$ if the coefficient is .10. To determine on which side of $c\,h$ the directions $c\,i$ and $c\,j$ must be drawn requires a careful inspection of the figure, with the principle in mind that friction always opposes the motion. It is also necessary to keep clearly in mind which part of the machine is being considered, as every force acts on two different parts in exactly opposite directions. We are considering the driving gear. The force $c\,i$ (or $c\,j$) is the pressure of the driven tooth against the driving tooth, and the motion of the driving tooth past the point c is toward the top of the page. Hence the pressure $c\,i$ (or $c\,j$) will be inclined toward the bottom of the page, so as to tend to oppose the motion.

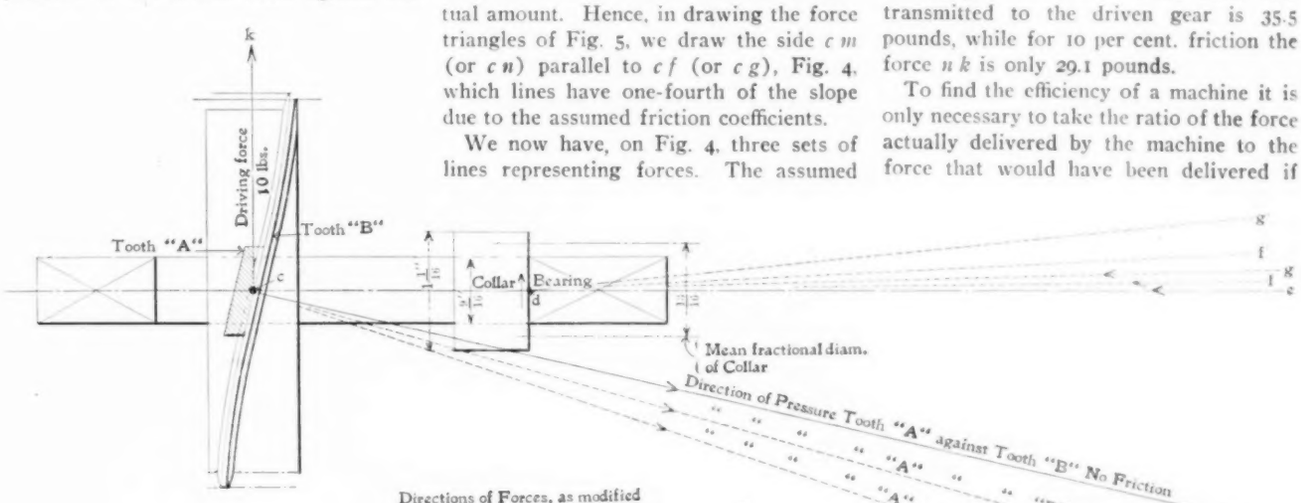
In the same way we see that the force $f'\,d$ (or $g'\,d$) is the pressure of a stationary bearing against a collar on the driving shaft. This force is the sum of a large number of small forces of the bearing against the collar, which we may assume to act around the circumference of the collar on the mean diameter of the rubbing surface—about 13-16 inch. Summing all these elementary forces at a point d on the side next the tooth contact we should have the force $c\,d$ with no allowance for friction, and, allowing the friction coefficients of .05 and .10, as before, we have had the force $f'\,d$ or $g'\,d$ inclined so as to oppose the motion of the collar against the bearing. But we cannot yet combine this force with the driving force $o\,k$ and the tooth pressure $c\,i$ (or $c\,j$) because it is not in the same plane, being only 13-32 inch from the shaft center, while the other forces are about four times as far (1.58 inches). But we can assume the thrust in a parallel plane four times as far from the center of the shaft without introducing any considerable error, if at the same time we reduce the friction effect to one-fourth of the actual amount. Hence, in drawing the force triangles of Fig. 5, we draw the side $c\,m$ (or $c\,n$) parallel to $c\,f$ (or $c\,g$), Fig. 4, which lines have one-fourth of the slope due to the assumed friction coefficients.

We now have, on Fig. 4, three sets of lines representing forces. The assumed driving force $c\,k$ is common to all the sets. The first set consists of $c\,k$, $c\,h$ and $c\,d$, the latter two giving the directions of the forces called forth by the driving force if there were no friction in the machine, and hence if the work received by the driving gear were all transmitted to the driven gear. Passing to Fig. 5, lay off $c\,k$ in direction and magnitude the same as $c\,k$ in Fig. 4, and through the two ends draw parallel to $c\,h$ and $c\,d$, Fig. 4, two indefinite lines $k\,l$ and $c\,l$, intersecting at l. These three lines, all measured to the same scale as the assumed force $c\,k$, represent the magnitudes of the three forces which act in equilibrium upon the driving gear. Hence $k\,l$, arrowhead (1), is the pressure of the driven tooth against the driving tooth, and $l\,k$ = 44.8 pounds, arrowhead (2), is the force which the driver would transmit to the driven gear if there were no friction.

The second set consists of $c\,k$, Fig. 4, as before, with $c\,i$ and $f\,d$, the latter two giving the directions of the forces when the friction coefficient is .05. The third set consists of $c\,k$, $c\,j$ and $g\,d$, the latter two giving the directions of the forces when the coefficient is .10. Passing to Fig. 5, and making the same construction with the second and third sets of lines as was made with the first set, we find that with 5 per cent. friction the force $m\,k$ transmitted to the driven gear is 35.5 pounds, while for 10 per cent. friction the force $n\,k$ is only 29.1 pounds.

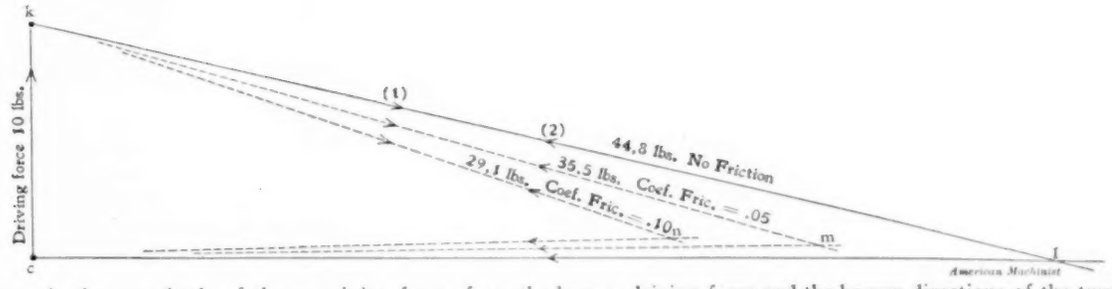
To find the efficiency of a machine it is only necessary to take the ratio of the force actually delivered by the machine to the force that would have been delivered if there were no friction. In this case, for 5 per cent. friction, the efficacy is $\frac{km}{kl}$, or $\frac{35.5}{44.8}$ pounds = 78.2 per cent. For 10 per cent. friction it is $\frac{kn}{kl}$, or $\frac{29.1}{44.8}$ pounds, or 65 per cent. These may be taken as closely representing the efficiency of this pair of gears under good and poor conditions of lubrication, respectively. These very low efficiencies, compared with the high efficiencies of good spur or bevel gearing, sufficiently account for the limited use of spiral gearing.

In some ways this example is not a good one to use as an introduction to this method. Several assumptions and short-cuts



Directions of Forces, as modified by friction

Fig. 4



To ascertain the magnitude of the remaining forces from the known driving force and the known directions of the two other forces.

FIG. 5. GRAPHICAL ANALYSIS OF FORCES IN SPIRAL GEARING.

are made which may give the impression that the problem could not be solved without such aids. This would be a mistake. The special devices were used for two reasons: incomplete data (journal friction being ignored and the mode of transmission of power *to* the machine part analyzed not being defined), and a desire to make the force diagrams as simple as possible. For an absolutely complete analysis it is necessary to know every force acting and how it acts; as, for instance, whether the shaft receives its power through a gear or a belt pulley, and where situated. In a case like this, where the problem is the efficiency of a certain machine element, it is quite unnecessary to suppose all the remaining circumstances of a complete machine. The assumptions are quick and harmless, though of course some experience in the work is necessary to enable one to see what it is safe to neglect.

It is not necessary, in order to get the efficiency, to suppose any dimensions or any definite forces whatever. The shapes or forms of the various parts, and the material and running conditions are the only necessary data. In this case, for instance, the efficiency of a pair of spiral gears of the tooth angles shown in Fig. 4, mounted on a shaft whose thrust collar has a mean diameter of about one-fourth of the pitch diameter of the gears, is given by the ratio of the lines $\frac{mk}{lk}$, Fig. 5, whether the gears are 3 inches or 3 feet in diameter, and transmit 1 or 100 horse-powers. The draftsman proposing to use such a gear may lay down the tooth angles and draw a few lines, and in ten minutes can get more information about it than a half-day's figuring would give him. And the best thing about it is its effect in educating the judgment on problems involving friction by the graphic way in which it shows up the large or small losses. After applying the graphic method to an assortment of machines or machine parts, one soon becomes able to recognize an objectionable form as soon as it is proposed, with the result of saving time in tentative design. "It's a good thing," and those who are not acquainted with it, and who would like to take it up, may find it fully explained in Prof. Hermann's little book, "Graphical Statics of Mechanism," published by the D. Van Nostrand Company.

Echoes from the Oil Country.

NATURAL GAS AND SNAKES.

It is not so much the work I did on one of the outside jobs that fixed it in my mind as it was another experience that came because of the job. There was nothing particularly inviting in a trip upamong the hills with the thermometer away below zero, but when the work has to be done somebody has to do it, and the afternoon train dropped me at President, where I took up the next stage of the trip in a lumber wagon.

It was a slow, cold ride, with the ground frozen hard and the road very rough. We would have gone slowly anyhow, as it was uphill nearly all the way. We went up by "horse's delight," and the place where the snake catchers go to get rattlesnakes, and finally, after dark, we turned off into the woods and by and by came to the clearing where the small sawmill was situated. It was a semi-portable one, intended to be moved when that tract was cut, and was run when in operation by a few men most of whom shantied there through the week. Now they were not running, and the owner and two other men, one of whom acted as cook, were all that were around.

The man that brought us up evidently lived somewhere in the vicinity, as I heard the mill owner arrange with him to be on hand the next morning to haul sawdust and cover the water line that ran from a spring to the boiler. The shanty where we were to stay was a board affair about 12x16 feet and perhaps 8 feet to the eaves from the ground. It was made of green lumber, had only been built a short time and was not as complete as intended to be later on. Cold weather and defects in the machinery had delayed them at the mill, so they had not done anything in the way of regular running.

In one end of the shanty and near one side was a door. Just inside the door on the other side was a cook stove with the front toward the center of the room. This stove was supplied with gas from a well about 300 feet distant, with an available pressure of about 375 pounds. The well was a new one and the pressure was not very regular. There was a valve at the well, another one outside of the shanty and one at the stove. There was also a branch pipe running up to give light. Beyond the stove were a rude table and a couple of benches, and at the far end a bunk ran across and was divided in the middle. There was no window of any kind, the only openings being the door and the opening the stovepipe went through.

After supper I was told about the job and also about the big gas well so near, and we could hear whenever they blew the water from her. I did not like the arrangement of our quarters any too well, as to get to the door we had to pass the stove, and if anything should happen to that gas it would be at the stove. However, I was there and in for it; but as I lay in the bunk I wondered if it would be possible to bunk a board off and get out through that end in case of necessity. I noticed that the gas came on much stronger at times, but that was due, so they explained, to the city's not using as much during the night. (This was in the gas field that supplies Oil City). I awoke in the morning to find I was all there and had neither smothered nor roasted, and was presently at work trying to make an old engine work like a new one, or better, and giving all sorts of advice as to best pressures, speeds, ways to handle injectors and other such like subjects that a job hand is supposed to be saturated with, and incidentally drilling out a lot of studs on top of the boiler and grinding in the safety valve, while I directed the two men with me how to put new gaskets in the heater and cylinder head and steam-chest.

Presently one of the men asked me if I had a pair of dividers handy (compasses he called them, of course), and I sent him to the shanty for them; it was about 150 feet away. He brought back my overcoat, which had been hanging back of the stove, saying he saw I had other tools in the pockets which might be needed. The man with the team had been hauling sawdust. A little after eleven o'clock I heard a dull boom and felt a jar in the direction of the shanty, which was also the direction of the gas well. Looking up, I saw fire pouring out of the ridge between all the boards of the roof and shooting out all around the eaves of the shanty. One man had started at the first alarm on a hard run for the shanty and I dropped my tools and followed. Just as he reached to open the door it was jerked open from the inside and a man rushed out with his cap, hair, gloves and overcoat in a blaze. This was soon extinguished, as was the fire in the shanty, which had burned up a lot of bed clothes and boots and working clothes hanging on the rafters, and charred the walls about half way down.

The man was not seriously burned, as he had been thrown to the floor by the explosion and had crawled to the door, the fire getting on him, likely, when he sprang up to get out. It was a close call for him, though, and that fellow wanting to borrow my dividers saved my overcoat which had hung just where the wall was charred the worst.

As near as we could figure out, the man had gone in to get warm just as the cook had gone to turn on the valve near the well to have more gas for getting dinner. Before going he had closed both the other valves as tightly as possible, but with the high pressure enough came through the three valves to keep lighted, and the teamster, finding a very small fire, had opened the valve at the stove, not knowing how things were, and when the pressure came it came with a rush that caused the explosion. A soon as he saw the fire, the cook ran back to the well and closed that valve and the fire went out.

If anyone wants a practical lesson in the penetration of gases he can get it in trying to hold natural gas with a good high pressure. Valves that will hold oil and water perfectly will furnish quite a fire, while a valve that is opened and closed often in a line soon leaks badly, and it is a nice job to refit it and make a perfect job. The only way I could ever get such valves tight was by handwork at the vise, and then it took a mixture of elbow grease,

ground glass, fine file, gasoline, lard oil and brains. I have seen many a man try them in the lathe and make them look fine, but they would not stand the test. They could fix a refinery valve that way all right, but gas was something else. As one fellow put it, "a valve that will hold a thousand pounds oil pressure seems to be a sieve with half that pressure of natural gas."

The way I hustled that job would likely have suggested piece work to an onlooker, but I had made up my mind not to tempt Providence too far by staying in that shanty another night. I would rather take a few chances on having to come back in warm weather, when the gas would be turned clear off, or I could sleep on the sawdust at the mill and risk a snake as a bed-fellow.

Speaking of snakes, one of our men was out once on a job a few miles further up the river and had to stay over night. The weather was warm and he sat out on the porch after supper. As it began to get dark, the man of the house came out with: "Say, stranger, you better come inside as the rattlesnakes come up on the porch nights, sometimes." "And," said he, "I got inside. I thought maybe he was joking, but I noticed the next day he carried a club with him right along, so I guess it was true enough."

I have seen quite a number of accidents with high-pressure natural gas since, and I treat it with the same respect that I accord to nitro-glycerine, knowing that undue familiarity with either of them is as much out of place as it would be with a man who is a boss of a gang for the first time and hasn't got settled to his job.

W. OSBORNE.

Letters From Practical Men.

A Decimal System of Numbering Working Drawings.

Editor American Machinist:

Apropos of the decimal system of numbering working drawings, I agree with Mr. S. L. G. Knox. Arbitrary and *consecutive* numbering is the best and only plan for identifying anything When you first start with any piece, drawing, pattern, casting or what not, give it a number and never change it, unless you change the piece, etc., itself, and then DO change it to the next number on your list. Don't have any ½'s, or ¼'s, or 042's, or 39B's, or any other symbolic numbers. Take the plunge at once and you will never regret it.

Just think how simple it is. A certain piece is, we will say, No. 3876. If any information is wanted in any department the number 3876 at once locates it, whether it be the number of a drawing, casting, pattern, shop, or job, ticket, cast card, special tool or jig.

When the card system is used, as I presume it is now very generally, it enables information to be obtained instantaneously, and for storing stock the arbitrary numerical method is above all the best.

By the way, I haven't heard yet of any concern making its drawings or blueprints on cards. I don't come in contact with draftsmen much, so it may be an old thing to them; but I find it practical in my business. In many machine shops the greater part of the drawings are small enough to go on cards, say, about 5x7, which is a handy size. I am not selling cards, but I'm somewhat of a cardophile."

ROBERT J. HEARN.

Editor American Machinist:

The adverse criticism of Mr. S. L. G. Knox of the decimal system of numbering drawings, at page 64, was of particular interest to me, as the system is still in the formative stage, and its disadvantages are what I am on the lookout for. I can answer some of Mr. Knox's objections.

It was not my intention to attempt to foresee the uses to which a machine part would be put. The "0" would be used only when the drawing was made with the intention that it should be used for several different machines and when the word *Standard* appears in the title. This would not in any way prevent a drawing which was not standard being put to as many uses as desired. Its number would be a distinctive number, and any part shown on it could be called for on the bill of material of an order, or by whatever method is used.

So far as I know, there are but two fundamental plans for filing tracings—one in which they are arranged in numerical order, and the other in which the arrangement is according to subject matter. The first has the advantage that the drawings may be filed according to size (a letter denoting the size) without interfering in any way with the system.

In both these systems an index must be kept and referred to; in the first system when a drawing is wanted and the number is not known, and in the second when the number is known but the subject matter is not.

In the decimal system the tracings would be arranged both by number and subject matter and could be found without referring to an index. The index would still be necessary, however, as I shall explain. Mr. Knox says that to maintain the system it would be necessary to re-trace many drawings, because they would fall under more than one classification. This same difficulty is encountered in libraries frequently. For instance, a book of biography and travel might be classed as either. The difficulty is met in this way: the book is numbered under one head as usual, and a second card is made out under the other head, containing the Dewey number in red ink which corresponds to this subject, and below this in black ink the number the book received. The number in red ink is in reality the number of the card, and indicates its position in the catalog.

If such a plan is followed with drawings, the result will be a Dewey catalog such as Mr. Knox agrees would be a good thing; but it would be unnecessary to refer to it until after a look through the drawer which should contain what you want. I get a better idea of what a drawing is by a glance of a second at it than by reading a card full of index matter about it.

Of course a classification which would suit one class of work would be wholly unsuited for another, but any classification could be used if it were put in a decimal form.

I have seen drawings which contained a drawing number, a case number, a drawer number and a symbol, the last indicating the size and type of machine to which the drawing belonged. All of these numbers serve useful purposes, and one decimal number would take the place of all. I cannot see that the system would "increase the number of things to keep track of."

HENRY L. HUTSON.

Editor American Machinist:

The following is a modification of the Dewey Decimal System as used in libraries. When this system was adopted by us it was intended to use it as far as possible as it generally used. This would give the drawing for a rock crusher the following number, 622.731, to which must be added, first, a letter to indicate the size or style of crusher, then a number to indicate the particular drawing under that style crusher. This would make the complete number for that drawing as follows, 622.731B26—quite a formidable number, to say the least. Besides this number there would be the general title and on a detail sheet the name of the piece detailed.

There were certain advantages in this system that were quite desirable, but the length of this number was such that it would not, in all probability, be properly carried out. The chief advantage was that all of one class of drawings would be found together in one drawer of the cabinet. To retain this feature and still do away with the large number for classifying, the following method was used:

The whole number preceding the letter was left off, leaving only a letter and one or two figures, and the title itself was used to classify the drawing. In this way we still had all the drawings of one class under one division and each set of drawings belonging to a certain machine had a distinctive letter, assigned successively as the different sizes in this class were drawn up.

Each class that we had to deal with was divided into subdivisions which correspond as far as possible with the decimal hundredths in the Dewey system, thus hoists were divided into Geared Hoists, Friction

Hoists. First Motion Hoists, Winzes, Winches, etc., and under each subdivision was assigned the whole major alphabet for individual machines, and if the major alphabet was not sufficient the minor could be used.

It will be seen that the Dewey classification was still retained and that all the drawers of the cabinet would be divided to conform with it, except that instead of the long number necessary in that system we are using the natural title of each drawing.

The letter proved to have another advantage. Thus, when speaking of a skip cage, by simply calling it Skip Cage B, the necessity of a long detailed description to indicate this particular skip cage was avoided.

The detail number following the letter will seldom, if ever, exceed two figures, as under each new letter the numbers again commence at 1.

This system has been giving good satisfaction in a shop doing a large variety of mining work and general repairing.

Like many other concerns, we also make a specialty of a marine gasoline engine. We have not applied this system to this branch of the business because the same pieces are used on so many of the different sizes of engines that a strict division between the different sizes would necessitate too many drawings of the same piece, and so for these drawings we use consecutive numbers for all the details.

The pamphlet issued by the University of Illinois and entitled "An Extension of the Dewey Decimal System," has been of great service to us in making the proper classification of the drawings.

A. B. Holley.

The "Difficult Case."

Editor American Machinist:

It seems to me that some of your correspondents are a little hard on "Needle's" friend, the new foreman. They hint that he was cowardly and behaved dishonorably to his employers in not grasping the situation as it stood and seeing the thing out to their satisfaction.

Now, let us look at it from another standpoint. What did the new foreman go there for? Was it not to *better* his condition? In a word, he sought happiness, which is really what we are all after, though often we call it money or success instead. He engaged with this company with the idea that his work would be nothing very different from what might be expected in almost any ordinary shop of today, and the company held the same idea, until he told them of the "conspiracy." He was under no obligation to remain, since the position had been misrepresented to him, even though unintentionally. Our friend saw before him months and months, perhaps years, of disagreeable surroundings, with no real certainty of his final success. While the "office" may have been with him at the start, he had no assurance that it would always uphold him as stanchly.

There are always two sides to a story, and these weak officials might soon have had their confidence shaken a little in the new man's ability by a few plausible lies and a little secret scheming from the other side, from these men who "merely wanted their rights." Their rights? No; that above all things was what they were most afraid of getting. They were narrow minded and, I suppose, poor mechanics; they certainly acted as such, else the new man would not have been needed. They evidently knew they were getting more than they deserved and more than they could get in open competition with others. So they guarded their positions at a loss to their employers, and undoubtedly would have been ready to slander and abuse any honest man who attempted to smooth out their deliberate mix-up. Not much happiness in that, I reckon, for our friend, unless unpleasant days and perhaps anxious nights constitute that state. "'Needle's' friend missed one of the opportunities of his life," did he? Yes, "he discovered a gold mine," and generously said, "You may give it to somebody else—someone who is working for glory, or who wants to be a second Sherlock Holmes; but that's not I. I have a silver mine hard to work and, considering everything, it pays fully as well as your gold mine, and in the end may perhaps pay better. Goodbye." Cowardly? Oh, no; only prudent.

Wilfrid J. Thompson.

Pittsburg, Pa.

Editor American Machinist:

"Needle," page 1432, last year, states a case. I think his friend will find similar conditions, in a greater or less degree, confront a new man in a majority of shops, especially so if he starts in to introduce new methods.

As to what to do under the circumstances, I can see nothing debatable. In the first place, a foreman must never be governed in his movements by shop gossip, nor should he take men such as he describes at their own valuation. If this foreman had gone along entirely regardless of the opposition and gossip, and had discharged the most aggressive agitator, the chances are twenty to one he would have had no serious trouble.

If there is a shop of 600 hands that can't run without one engineer and five subforemen, if I was in charge I should let them shut down a month to realize "where they were at." These men might die; then the shop would have to go out of business!

I can say nothing as to the experience and ability of "Needle's" friend, but in the present instance he took a plain little everyday bluff, and took it easily. Taking into consideration all the circumstances, perhaps the resignation was best. From the indicated flexibility of vertebrae in the office, a foreman could expect little support from that quarter. I should think it a good shop for a foreman to keep out of. I should not care to work for a concern that would not sacrifice a few thousands to right such a state of affairs.

On the other hand, I should think the firm would be better off without a man who would "lay down" so easily. I have no doubt most foremen have had experiences similar to that of "Needle's" friend. I have. The only thing to do is to do the right thing, and what is to the best interest of the shop, without working any injustice to your men.

When a man thinks he is best serving the interests of all concerned by letting four or five "lunkheads" run the shop, I am inclined to doubt his judgment.

W. A. Warman.

Editor American Machinist:

The article at page 1432-33, Vol. 24, by Needle," about "A Difficult Case—What Should be Done?" reminds me of a somewhat similar case that occurred in the West about two years ago. A department of a large manufacturing concern had been running in the same manner as described by your correspondent. A new foreman was engaged and he ran against four men who had conspired to block his efforts toward system and increased output. He handled them very carefully until he was *sure* that they really had agreed to quit in a body if he should discharge any one of them. He did as your correspondent's friend did—tendered his resignation to the manager—and on being pressed for his reasons for wanting to resign stated the case. The manager would not hear of it. He told him he would investigate, and, together they would handle the case to a finish; that is, he assured the foreman of his support no matter if the whole works was shut down temporarily. The manager's investigation convinced him that these four were causing the company loss every day, and he saw that they should be let go. They concluded to pattern a little after the four worthies and to conspire a little themselves, as it would be a very expensive matter to let them go at once. So four new men—good, honest and trustworthy men, experts in their line—were engaged at a salary as high as the best of the four kickers. It should be mentioned that the wages were already higher than other works were paying, so there was no cause for dissatisfaction on that score. These new men had the matter explained to them and were placed at helping at various jobs, and they watched as much as possible the ways of getting the work out, tools, jigs, kinks, etc. In about one week's time they reported that they had no doubt that they could handle the work. Fortunately, one of the conspirators laid off to take his periodical spree, and the best new man was immediately put in his

place. The others, being taken unawares, decided to wait until they could confer with their partner. In three days he presented himself for work, and he was allowed to go to work, but was told that as the work had got behind and hurry orders were coming in he must have an assistant. He demurred and threatened to quit, but was neither argued with nor discharged. He worked on until noon, when the four came to the foreman, saying they would all quit if the assistant was not removed. The foreman said he was very sorry they were quitting, but that the assistant would have to remain. They immediately walked out, expecting a shutdown within a week; but, on the contrary, a larger output was secured, enabling more men to be put at work, as by a little foresight the men were secured and instructed to be ready when called on. This was all done without discharging anyone. The parties discharged themselves on account of foolishly imagining that they were in control of the situation. Thus, by going slowly, allowing things to mature slowly, even at a slight loss, great damage was avoided, a delicate matter was adjusted and everything was lovely. The foreman was glad he had not resigned, the manager was glad, a different atmosphere was noted, an era of good feeling was started, and all the men in the department now are his staunch friends and respect him. He has not discharged a man since that time, as any suggestion made is acted upon readily and everyone is well paid for his work. This actually occurred and was overcome in the manner stated. Some of the methods used might apply to "Needle's" case.

"THREAD."

Editor American Machinist:

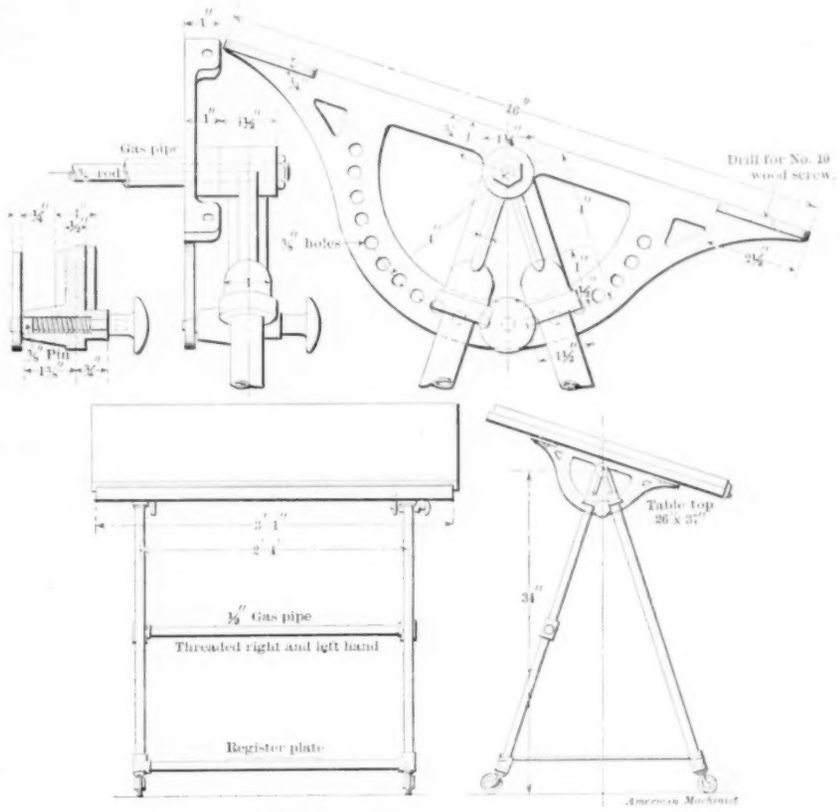
The article in your paper concerning "A Difficult Case—What Should be Done?" did not seem to me to be so interesting, but seeing the number of persons giving advice in the last issue I am led to agree with Abraham Lincoln's statement concerning the man who might fool all of the people some of the time. That chap evidently fooled nearly everybody but himself. If we read between the lines in his paper it is easy to discover that he, himself, saw that he was up against a proposition beyond his caliber, and the point was to find a way to let himself out easily without the concern discovering that he was not the man for the place. This he did very nicely, as was patent in his article. This is assuming that the letter given him by his employers was from the heart on their part. This I do not know, as their side of the story has not been heard. My own opinion when reading the article was that "Needle's" friend was a pretty shrewd, foxy kind of a man and knew how to get out of a very bad hole and save his reputation.

W. S. ROGERS.

A Drawing Table of Gas Pipe.

Editor American Machinist:

A stiff and serviceable drawing table may be made out of gas pipe without much expense either for labor or material. The accompanying sketch shows such a table, the legs and cross braces being of ½-inch gas pipe for a small table. The only castings for which special patterns are needed are the A-shaped pieces into which the legs are screwed and the segments which serve the double purpose of stiffening the wood top and also of affording room for a row of holes into which a pin may engage to fasten the top at any angle. The top turns on a ⅜-inch rod which runs the whole length of the table through a piece of pipe which acts as a separator, a nut on each end of the rod binding the whole together. The fastening device is a spring pin at the right-hand end of the table, details of which are shown. A register plate across the two bottom pipes serves as a foot rest.



A DRAWING TABLE MADE OF GAS PIPE.

It will be noticed that no provision is made for adjustment in hight and none is intended. During an experience of nearly twenty years on a drawing table easily raised or lowered the writer does not recall changing the hight half a dozen times, and in an examination of all the tables in an office where the hights of the men range from 5 feet 4 inches to 6 feet 2 inches, the tables were found to be within two inches of the same hight and might probably all be alike without inconvenience, the adjustment being effected by tilting the table top or by varying the hight of the stool.

W. H. S.

Building American Machinery in Russia.

Editor American Machinist:

Regarding the paragraph in your paper at page 134 regarding my presence in Milwaukee and its aims, I would say that in the first place I am conducting no negotiations of any kind, contracts having been entered into by our firm with the Bucyrus and Gates Iron Works companies some time ago. The object of my visit here is purely technical. As far as the statement regarding cheapness of construction is concerned, I would like to say that nothing was ever said by me regarding the stamping out of shovel dippers. My words referred to round-bottomed elevator dredge buckets and their lips, which, as I think you will agree, is quite another thing. The Poutiloff Works, of St. Petersburg, is the third largest engineering establishment in Europe, employing over 12,000 men, and in the last few years great sums have been expended in bringing the plant up to a high state of efficiency. Taking into account as well the very low rate of wages ruling in Russia, I think I was not far wrong in saying that some parts of these machines could be produced in Russia cheaper than here in the United States.

W. M. POTTS.

[The expression "Some parts of these machines" is of course essentially different also from the language of the press

dispatch upon which we commented. It will be remembered that we distinctly exonerated Mr. Potts from responsibility for the langugage of the dispatch, but as it was calculated to create a wrong impression we thought that a machinery man who had been in Russia might properly comment upon it.—Ed.]

The Origin of the Premium Plan.

Editor American Machinist:

I have read the article on "The Premium Plan at the Works of David Rowan & Co., Glasgow, Scotland," at page 49, and the appended personal statement of Mr. Halsey with interest, and I wish to endorse all that Mr. Halsey has said. When he gave his excellent paper on "The Premium Plan of Paying for Labor" to the American Society of Mechanical Engineers, ten years ago, I was, so far as I know, the first to take it up and put it into practical use. Since that time I have used it in many factories doing different classes of work, in all departments, and employing as high as 800 men, down to little plants employing but ten or twenty, and I have always given Mr. Halsey credit for being "the father of the premium plan." In these places wherein I have used it, I have not followed the exact formula as originally given by him, because I saw that it possessed an elasticity that no other method or system of paying wages could have.

While I feel that I was the first in following Mr. Halsey's methods, I have since discovered that it was in use in a machine shop in this country several years before he gave our society his paper, and I have also discovered upon investigation that he fathered it in that particular place. I think he is fully entitled to all credit for his unpatentable invention, which is very similar to my invention for keeping cost and time on a clock, whereby the minutes of the workman are registered and become the unit of calculation in paying for labor and distributing the items of production and unproduction in their respective accounts. Everybody will use these inventions, there will be no infringement, and we can both enjoy the fruits of our labor in the hereafter, if we get there.

W. S. Rogers.

The Tramp Draftsman.

Editor American Machinist:

The writer was much interested in the method of a tramp draftsman who happened in the other day. I have seen several articles in your paper in regard to tramp machinists, but never a word about tramp draftsmen, probably because, to anyone who comes in contact with them right along, they all seem tramps. Pittsburgh probably has more engineering talent to the square inch than any other city in the country. It would be hard to estimate the number of men who earn their living by pushing a T-square in this city, but they run up into four figures, and so it happens that this city is the Mecca to which the fakirs of the cult flock. Fakirs some of them are, in more ways than one. They come and go like drifting sand. Most of them have dyspepsia, and one and all have a desire for new things. One large engineering office here, having about eighty men, averages to keep a man only two months. Much might be written about the draftsman. The general public knows him not, but there is no body of men in the country who bring about such wonderful results. And so he goes on in obscurity, little appreciated and poorly paid.

We had a man drift in from Cripple Creek the other day, who was an example. He had worked for every famous engineer and inventor since the civil war. He had designed the first typewriter, the first steel construction office building, the first cash register and the first automobile, besides a lot of unimportant things. He told us that he had taken out but seven patents and never got more than $5,000 for any of them. One could not mention a large concern he had not worked for, from the Portland Company, in Portland, Me., to the Union Iron Works, in San Francisco. Two of his neighbors in the office prepared a schedule giving his employers and time of service, as reported piecemeal by himself, and were surprised on totalling the time to find that he had seen over ninety-four years of active service.

He was not over thirty-five in appearance, however, and, strange to say, could do first-class work. He had a way of preparing the preliminary layouts of his jobs that was worth recording. The work that we put him on was straight designing, subject to the chief engineer's approval, and, following the usual method, he made pencil layouts of all the parts before actually detailing anything permanently. It being original work, some parts were laid out three or four different ways before being definitely decided upon. This meant having a lot of pencil drawings lying around and getting lost and soiled. But Mr. Tramp had a better way. He put about a dozen sheets of drawing paper on his board when he started in, and as he finished a sheet he took the tacks out of the lower edge and turned it back over the upper edge of the board. Thus he had a chance to draw on the next sheet and could at any time turn any sheet back for reference. By putting a few tacks in the lower edge he could change or add to any sheet in his "book," as he called it.

It was a new wrinkle to the writer, one of several which the tramp had picked up, and which stamped him as a good, wide-awake man. But the question arises in regard to his wisdom: Had he been wise he would have said never a word about his experience, as his work spoke for him. There was no necessity for him to keep the "hot air" going all the time. All that he needed to do was to keep quiet and saw wood. And there are others in precisely the same situation.

Pittsburgh, Pa. F. W. Harris.

The Bonus System of Rewarding Labor—Popularity of the Premium Plan Among Workmen.

Editor American Machinist:

Mr. Warman's article on "The Bonus System of Rewarding Labor," at page 98, is certainly interesting, but it seems to me that there are just a few cobwebs still interfering with his vision.

I do not suppose that Messrs. Gantt, Taylor or any other advocates of the premium system claim that it is perfection; but only that it is a means of increasing the output, and at the same time giving the workmen a fair remuneration for their efforts in bringing about this increase.

It seems to me that Mr. Warman puts himself in the same class as the "Fresh Tech." when he says of Messrs Gantt and Taylor, "I don't think they know exactly the feeling that exists in their own shop in regard to their system," and immediately follows it up by saying that he himself has no personal knowledge of the Bethlehem works.

As a matter of fact, Dame Rumor says the premium system at the Bethlehem works acts as a drawing card to the best and brainiest mechanics, from which it is only reasonable to infer that there must be a general air of satisfaction about the place, as good mechanics are not, as a rule, grumblers.

In one shop, of which I have some personal knowledge, in which all the work cannot be done on premiums, the complaints are not made when a man gets a premium job, but when he gets one on which there is no premium, which I think is good evidence of how the mechanics themselves regard the premium system.

Mr. Warman says, "Co-operation with the brains in the shop can do no harm," and in the same breath condemns the suggestion box, which is put in the shop for exactly that purpose. The manager or superintendent takes this method of finding out where the brains are located, so he can co-operate with them. The man who is afraid to put a suggestion in the box better go out of the business.

I should like to know what kind of work was being done on that big radial drill and how the drill was ground, and hope Mr. Warman will be broad-gage and liberal enough to tell us all about it.

Providence, R. I. D. Addie.

Marking Blueprints.

Editor American Machinist:

Nearly everyone who handles blueprints finds at times that he would like to make additions or corrections to change a dimension here and there or add notes. Occasions come up every day. There are several ways to make these corrections, several wrong ways and one right one.

Some people mark the print with a lead pencil and some use ink, but any combination of black on blue is scarcely noticeable. It has become the custom, therefore, to use a soda solution, using it as ink, and the result is a white line not very different from the print. The soda on the surface of the paper collects dirt and the lines fade and lose their original intensity.

The right way is to write your figure in ink—ordinary Carter's or any other fluid that is acid-proof—then take your ruling pen and put a blot of soda over the spot. This whitens the background and turns the ink jet black, and it is done in half the time and twice as nicely as any other way. The white spot is there to stay and the ink will never fade.

Pittsburgh, Pa. F. W. HARRIS.

Rail Clips and Stops for Crane Runways.

Editor American Machinist:

I send herewith sketches of what I consider superior as well as cheap forms of rail clips and stops.

Fig. 1 shows the clips in position and Fig. 2 shows details of same for a 100-pound rail. It will be noted that the hight of clip C_1, Fig. 2, is 3-16 inch less than that of C_2. This is to allow the strip A, Fig. 1, to be placed under C_1 and, running the full length of the crane girder, prevent the rail spreading.

This construction is superior to dowel pins spaced at intervals beside the rail, because it cannot work loose, while dowel pins may. It is also obviously much cheaper, and for the same results requires less care in construction.

Fig. 3 shows an end stop for a 150-pound rail. This construction is better than the curved-up rail and bracket often used, because, in case the crane runway is to be extended, as is often required, it is only necessary to unbolt the stop and move it to the end of the extended runway. In the case of the up-curved rail and bracket, the end rail length must be taken up and moved with the bracket to the new runway end. In addition to this disadvantage in providing for extensions, this stop is more expensive to make. Either form can be made strong enough.

F. D. BUFFUM.

Laying Off Angles Without a Protractor.

Editor American Machinist:

In laying off angles on the drawing board there are some short cuts that are not widely known. Of course a protractor can be used or a scale of chords, but this means additions to one's kit, which, while very nice, are expensive, and besides it is a very simple matter to place a mark on a scale that will make it useful as a scale of chords and one that will be right at hand when wanted.

On a decimal scale this is done by assuming 1 inch as the chord of 10 degrees. The radius at which this is true is found by dividing one by the chord of 10 degrees at a radius of 1, as follows:

$$\text{Sin. } 5^\circ = .08715.$$

$$\text{Chord of } 10^\circ = 2 \times .08715 = .1743.$$

$$\frac{1}{.1743} = 5.74'' = \text{radius at which one inch is the chord of 10 degrees.}$$

In case it is not desired to use a decimal scale, 1¼ or $\frac{1}{8}^0$ inches can be assumed as the chord of 10 degrees, the radius in this case being:

$$\frac{1.25}{.1743} = 7.22 \text{ inches.}$$

Knowing that 1 inch is the chord of 10 degrees, it is practically accurate to take 1-10 inch as the chord of 1 degree. The error is small, and subdivisions of a degree can be obtained as follows:

1-20 inch = 30 minutes.
1-30 inch = 20 minutes.
1-40 inch = 15 minutes.
1-50 inch = 12 minutes.
1-60 inch = 10 minutes.

In this way pretty close results can be had and in a similar manner subdivisions can be figured for the ordinary scale.

For example, to lay off an angle of 33° 30′, the compass must be set to the radius 5.47 inches and an arc struck. The dividers are then set to the chord of 10 degrees —1 inch—and three spaces are stepped off. From this point the chord of 3° 30′ remaining is laid off as 7-20 inch. The accuracy of this method is very easily tested by laying out an angle of 60 degrees and working back; it will check if carefully done. A. D. WILLIAMS.

Lard Oil by Telephone.

We have received from the Truxal & Painter Machine Company, of Chattanooga, Tenn., a letter enclosing a proposition from the Valley Lard Oil Company, in which, as usual, they offer to furnish a "half barrel of Extra No. 1 Lard Oil" at less than its value because they wish to dispose of it to save returning. Regarding this matter the Truxal & Painter Machine Company write us:

"Ordinarily the plan pursued by these 'Unfortunate Shipment-Oil Companies' is somewhat different here, as we frequently receive a telephone message stating that this is Mr. ——, agent of the —— Railroad Company, and that he had at the freight depot one or more barrels of extra fine lard oil, which had been consigned to a party who refused to accept it and that the shippers had notified him to dispose of it to the best advantage and remit them the amount realized after deducting freight charges, and that he (the agent) desired we make him an offer for the lot, which offer he would accept, provided it would amount to a certain sum. However, as we are readers of the 'American Machinist,' we have not as yet purchased any gold bricks under the name of 'Extra No. 1 Lard Oil.'"

Now They Build Them of Steel.

"The Engineer" publishes some photographs of some very old hammer heads found upon the site of an old iron works near Etchingham station, on the South Eastern Railway, and in the concluding paragraph says:

"Unfortunately there is no name or date on either hammer or anvil, but they were probably in use in 1660, as at about that date Charles II. closed nearly all the Sussex and Kent iron works, as it was feared that all the oak trees would be used for charcoal, and there would be none left to build war vessels."

An Invitation.

We regret exceedingly that we have been obliged to decline the invitation printed below, but at the first opportunity we will go and find fault; though we shall probably miss the luncheon and the antidotes:

THE OFFICERS
OF
THE CARBORUNDUM COMPANY
CORDIALLY EXTEND TO

Editor American Machinist

AN INVITATION TO FIND FAULT WITH

THE COMPANY'S NEW OFFICE BUILDING

ON WEDNESDAY AFTERNOON, JANUARY TWENTY-SECOND
FROM THREE UNTIL FIVE O'CLOCK

AN ATTEMPT WILL BE MADE TO SERVE A LUNCHEON THE COMPANY'S CHEMIST, WITH A LINE OF POWERFUL ANTIDOTES, WILL RENDER ALL THE ASSISTANCE HE CAN.

N. B.—IT IS EXPECTED THAT THE INVITATION TO FIND FAULT WILL BE ACCEPTED LITERALLY BY THE AGGRESSIVE SEX ONLY. MEN WILL FIND THAT THEY WILL HAVE AN EVEN SO MUCH NICER TIME IF DURING THIS ATTRACTION THEY LOOK AS PLEASANT AND SAY AS LITTLE AS POSSIBLE.

NIAGARA FALLS, N. Y.
1902

The West Side Branch of the Young Men's Christian Association of the City of New York celebrated its fifth anniversary at the Association Building, 316 West Fifty-seventh street, on Monday evening, January 20, 1902. The association has made remarkable progress in the past five years. Starting with 243 members on December 31, 1896, has grown until it now has 2,127 members. It has a well-equipped gymnasium, a large swimming pool, thirty-seven evening educational classes, a library of 45,000 volumes, an attractive course of entertainments free to members, a boy's department numbering almost 300 with separate gymnasium and class rooms.

In Smyrna, Turkey, there are three large forges or foundries—D. Issigonis, Rice Bros. and Rankin & Dymas. The last named makes Galloway boilers up to 100 h. p. Among the products of Issigonis and Rice are steam towboats, boiler work, hydraulic presses, pumps and mills.

AMERICAN MACHINIST

Published at 218 William St., New York, every Thursday by the

American Machinist Press.

[INCORPORATED.]

Also published at 34 Norfolk St., Strand, London, W. C.

Correspondence on mechanical subjects solicited. Name and address must always be given—not necessarily for publication.

Address all business communications to the American Machinist Press. Matter for reading columns may be addressed to the Editor.

Subscribers can have address changed at will. Give old and new addresses. Date on wrapper denotes end of month in which subscription expires.

Subscription Price:

$4 per year, postage prepaid, to any post office in North America, $5 in all foreign countries except Europe; Twenty-five Shillings there. No back numbers beyond current year. For sale by newsdealers generally.

European subscriptions served by the AMERICAN MACHINIST CO., LTD., 34 Norfolk St., Strand, London, W. C.

Entered at New York P. O. as mail matter of the second class.

Cable address, "MACHINIST," N. Y.
Lieber's and A B C Codes.

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The Fourth Avenue Tunnel Accident and Coroner's Verdict.

The verdict of the coroner's jury on the recent "accident" in the Fourth Avenue Tunnel of this city is a source of gratification to all good citizens. The officers of the company endeavored to unload the responsibility upon the engineer of the colliding train and to shield all others. The attempt to shield others was in fact fairly grotesque. If the testimony of most of the officers be taken at its face value, the New York Central & Hudson River Railroad is to be considered as about the most disorganized institution of its magnitude on the face of the earth, as by it no one appears to be responsible for anything. Of course, however, this testimony is not to be taken at its face value, as, if the real condition of things was what it is shown to be, the road would be scarcely operative. The responsibility no doubt exists, but it has been denied in order to shield the officers of the company from blame.

In view of the rule of the road which requires that if an engineer cannot see the signals he shall bring his train to a stop, which this engineer did not do, it is not easy to see how the jury could have failed to hold the engineer as in some measure responsible; but, no doubt, the fact that the rule was not enforced while failure to bring in the trains on time was followed by severe punishment, furnished the reason for practically exonerating the engineer. Establishing the rule that trains should stop in case the signals could not be seen and then nullifying it by practically ignoring infractions of it and, in effect, compeling these infractions by requiring schedule speed to be made, appears to have been nothing less than a convenient subterfuge for shouldering the blame on the engineer and shielding all others in case of accident.

More grotesque than the evidence of the railroad officials is the "remedy" for the condition of things which is urged by "The World" of this city, which thinks that the rule "but one train at a time on any one track in the tunnel" would solve the whole problem as completely as Columbus solved the problem of making an egg stand on its end. It would undoubtedly stop collisions in the tunnel, but it would result in moving about one-quarter of the traffic in the rush hours of the day.

The condition of things which "America's greatest railroad" has maintained in this tunnel has long been dangerous and disgraceful. In spite of the energy and fearlessness of our new District Attorney we have little hope that actual punishment will be visited upon the officials of the road, and it remains to be seen whether the force of unanimous public opinion, of which the verdict of the coroner's jury is but an expression, will have any substantial effect.

The Rubber Trust Lesson.

We have done what we could from time to time to point out the essential and fundamental difference between real monopolies and mere large aggregations of capital for the purpose of carrying on business on a large scale. We have insisted that the cry of monopoly is too loosely applied and that while a street railway or a steam railroad may be, and nearly always is, more or less of a monopoly, a department store or a large company operating a number of manufacturing establishments may not be, and in fact usually is not and cannot be a real monopoly. The recent failure of the rubber trust is an illustration of the point. When this trust was being formed J. R. Dunlap, proprietor of the "Rubber World," took the position that it could not succeed. There were some pretty "strenuous" goings on about that time in which accusations of blackmail, libel, browbeating, etc., were pretty freely handed back and forth, but Mr. Dunlap stood to his guns and stated the situation as he saw it as follows. Speaking of the Rubber Trust, he said: "It must be plain to any well-informed man of business that the principles of success applying to enterprises of that peculiar character [The Standard Oil Company] and of such enormous proportions can have no application to a distinctly manufacturing and commercial business like that of India-rubber manufacture. In the first place, we know definitely that the supply of crude rubber is practically inexhaustible. The number of natives in the tropics who can be sent into the rubber forests is unlimited; and hence both the supply and price of crude rubber are regulated closely by the demand, precisely as in the case of wheat, oats, and corn. More than this, crude rubber is small in bulk, can be easily transported and every vessel that sails the seas can carry a batch to the market where needed. What we oppose is a movement of Wall Street operators which has for its avowed object the ultimate control of the entire rubber industry under a single influence—that control to be gained by a bold policy of merciless extermination for 'those concerns which the organizers of the new concern do not propose to take in.' The weapon with which this extermination is to be accomplished is the 'power, wielded by a single hand,' to control both the supply and price of crude rubber. This is, of course, impossible, as experience has repeatedly demonstrated; and hence there is no permanent danger. In such a contest there can be no doubt of the issue: the men of the rubber trade will win gloriously. And long before this passing craze for trusts has run its course we shall see the ranks of anti-trust converts augmented by scores of men who are just now dazzled by the glittering possibilities of trust 'securities.'"

That Mr. Dunlap was right about this has been shown by the course of events

and our readers will be able readily to draw parallels between the situation as thus set forth and the conditions that prevail in certain lines of machine construction. The proprietors of machine-building establishments, no matter how much capital they may possess nor how many large manufacturing establishments they may own and control, must face either actual or potential competition, so long as they do not control materials or supplies or lines of transportation either directly or indirectly. Of course, if they for instance get special rates of transportation on materials or finished goods—rates not obtainable by their competitors—then to that extent they partake of the advantages of a monopoly—a railroad or highway monopoly—and it is the monopoly itself that must be abated in order to establish just and fair conditions; it will do no good to rail at those who take advantage of it and it will especially do no good, but harm to cry monopoly at every large aggregation of capital regardless of whether or not its business partakes of the nature of a monopoly.

We have said from the beginning, and we still believe, that the combinations among machine builders will succeed just in proportion as they follow good business methods and avoid the idea that they can do as may please them without being called to account as other business enterprises are. The Standard Oil Company, the United States Steel Company, and most or all railroad companies are more or less complete monopolies because they control supplies of materials or lines or transportation, or both, that prevent free competition by other capitalists. The ordinary large business enterprise, though perhaps known as a trust, is differently situated and the distinction should be more generally and more clearly kept in mind.

The Steel Trust Situation Continues to Unfold.

Those who are inclined to think that the United States Steel Corporation has designs upon the industries of the country beyond anything that has yet been revealed gained an argument for their contention at the close of last week. It was announced that E. H. Gary, chairman of the board of directors of the steel trust, has been elected to a similar office in the Allis-Chalmers Company. Chairmanship of the board of directors of a company, as is well known, is an office of such importance in determining the management as often to overshadow even the presidency. It is therefore evident enough that the Allis-Chalmers Company has been swung into line with the United States Steel Corporation on a community of interest basis amounting probably to an absorption in the steel trust. In this connection it is interesting to note the representation of the latter on the board of directors of the new Chicago Pneumatic Tool Company, of which fact little notice seems to have been taken. It would seem that the turn of machine tools ought to come before very long. Indeed, there have been rumors within the last few days of an attempt on the part of New York parties to form a combination among New England tool builders. That anything like all the largest New England tool builders would assent to the arrangement in the case referred to we very much doubt, and whether the promoters have any sort of an understanding with the United States Steel Corporation we do not know.

It has been suggested that the steel company is to engage in shipbuilding and to control all the details of the work from start to finish. The acquisiton of the Allis-Chalmers Company does not indicate that the aims of the steel trust are limited to the attainment of this object, since Allis-Chalmers products have little to do with marine work. On the other hand, it is true that both in the line of mill engines and mining machinery the product of the Allis-Chalmers Company can conveniently be utilized by the steel company in its legitimate sphere, and the new move does not of necessity imply a policy to enter further fields.

Meanwhile, competition against the steel trust continues to grow. Its most important rival, Jones & Laughlins, Ltd., is said to have concluded the purchase of several tracts of ground in Pittsburgh to make room for an expansion of the works. This will give the firm 200 acres, all told, in that city, and it is important to bear in mind that they have their own ore mines. A meeting of sheet steel manufacturers is to be held in Pittsburgh, February 3, with a view to forming an association to regulate prices and one to provide a supply of sheet bars which they are meeting with difficulty in obtaining from the United States Steel Corporation. Meanwhile, it is reported that a steel trust is being formed in England to resist American invasion, and a rumor of like character has quite recently come from Germany, although the iron industry of that country is already pretty well congregated in "syndicates." In fact, both on the part of the United States Steel Corporation and those outside of it, at home and abroad, it looks as if the show had only just begun.

The Cost of Living and Wages.

Recently we are hearing a good deal about the increased cost of living and some remarks made by Mr. Carnegie in a public address to the effect that wages tended constantly to increase while the cost of living tended to decrease have stimulated the production of some figures and among the most prominent and perhaps the most reliable of these are taken from some recent carefully made figures promulgated by "Dun's Review." These figures, which are given in the form of a table, show that between January 1, 1898, and January 1, 1902, the cost per annum, per capita, of the following things consumed by members of American families have increased from $70.94 to $101.59, which is an increase of practically 45 per cent. The classes of articles named are as follows: Bread-stuffs, meats, dairy and garden products, other foods, clothing, metals, miscellaneous.

According to this the wage-earner who is as well off to-day as he was in 1898 should of course have had a corresponding increase in his rate of wages. That is to say, if he were earning $2.50 per day at the beginning of 1898 he should now be making $3.62 per day; if making $3.00 at that time he should now draw $4.35, and the laborer earning at that time $1.25 per day should now be earning $1.81 per day.

We have noted no such increase in editors' wages and we all know that the workingmen are not doing anything like this, and it is therefore demonstrated, so far as as these figures go, that those who work for wages are relatively less well off at the present time than they were four years ago. It is also quite certain that the selling prices of most of the things produced by workingmen have not increased in any such ratio. It is quite certain that there has been no such increase of values in machinery lines as would amount to 45 per cent. between the dates mentioned, and in fact it is doubtful if there has been an average increase of 10 per cent. above that which is fully accounted for and which must be paid out of the gain of machinery manufacturers in the shape of increased cost of raw materials.

This leaves the probable benefit of the present good times in which a higher scale of prices prevails as compared with former ones to be attributed to the probable, more plentiful and more steady employment and to the working of industrial establishments more nearly up to their full capacity.

Wonderful Newspaper Discoveries.

The ease with which utterly ridiculous technical or scientific stuff can be imposed upon the local correspondents of the Associated or metropolitan press, can be transmitted over the wires and published as though it were an important discovery or announcement is a source of constant wonderment to those who are to any extent versed in such matters and who are in the habit of using at least a little care in making statements pertaining to them. For instance, we have recently been gravely informed by telegraph that in Missouri an instrument known as the gyroscope has been discovered, and it is further stated that by oscillation of the axis of said gyroscope the North Pole is determined in a better and more reliable way than the compass can do it. But worse than all perhaps is the announcement flashed over the wire that a young lady (also residing in Missouri) has discovered a means of trisecting an angle, and this is announced as an important thing, as though no one has

ever known until now how to trisect an angle. Quite an attractive story is made of this and the young lady is made to say how she came to make her invaluable discovery, and the dispatch ends up as follows: "When the problem was given to me I immediately saw a possible solution which proved to be the correct one. The trisection of an angle I consider the key to perpetual motion. I now have the secret and in a few months hope to have a machine completed." Thus we have the germ of another Keeley affair, though it is not likely that this germ will multiply and grow and develop as the Keeley germ did.

The question of a law for an eight-hour day in the mines is being considered in France and the metallurgical interests are apprehensive that it may, indirectly at least, affect all coal consumers. Employers are addressing protests against the law to the parliamentary labor commission and among these is one on behalf of the iron-mining interests, which sounds a little peculiar. It takes the ground that the effective hours of labor are eight hours at present and that under the proposed law they would be only six hours, because from the nominal time would be deducted that required in descending the mine, preparing to go to work, taking a "small breakfast," a principal noonday repast, etc. According to this, lunch time in France seems to be reckoned as part of the nominal hours of labor. They are gross instead of net. Consequently it is possible that when we in America are judging of European labor conditions we are frequently misled through a misapprehension of terms, and that our practice is correspondingly misunderstood abroad.

Examination for Chief Mechanician.

The United States Civil Service Commission announces that on February 26, 1902, an examination will be held at various places for the position of chief mechanician in the National Bureau of Standards, at a salary of $1,400 per annum, and other similar vacancies as they may occur. Applicants must show in their applications that they have had at least five years' actual experience as instrument makers. Persons who desire to compete should at once apply either to the United States Civil Service Commission, Washington, D. C., or to the secretary of the local board of examiners for application Forms 304 and 375, which should be properly executed and filed wtih the Commission prior to the hour of closing business on February 17.

Technical Publications.

"Water Tube Boilers." By L. S. Robertson. 213 5½x8½-inch pages, with 171 illustrations. D. Van Nostrand Company, New York Price, $3.

This book is the outgrowth of a series of lectures at University College, London. It opens with an account of the historical development of water tube boilers and continues with a statement of the leading principles of construction, the arrangement, proportions, efficiency, etc. From this on the book is chiefly descriptive, about all types of boilers which have attained any prominence being illustrated and described. The last chapter relates to boiler accessories—reducing valves, feed water regulators, filters, heaters, etc. While due attention is given to American types of boilers, the American reader will probably find the chief value of the book to lie in the information given regarding the work done in this field abroad.

"Velocity Diagrams; Their Construction and Their Uses." By C. W. MacCord. 116 6x9-inch pages, with 83 illustrations. Wiley & Sons, New York. Price, $1.50.

This book relates to a method of study of mechanical movements from a standpoint which is often useful and always interesting. The mechanisms discussed may be broadly described as systems of link work, and the objective point of the study is the finding of the velocity at any moment of some driven point, the velocity of the driving point being known. Large use is made of Professor Reuleaux's method of instantaneous centers, and some surprising and original results are obtained. In many lines of work a knowledge of the methods set forth will be found of decided usefulness, while no student of mechanism can fail to find them of a high degree of interest. The methods are graphical, with here and there an algebraic expression that should embarass no one.

The Annual Report of the Board of Regents of the Smithsonian Institution for the year ending June 30, 1900, is an unusually interesting volume. Among other things it contains splendidly illustrated articles on "Progress in Astronomy During the Nineteenth Century," "The Pekin Observatory," "Progress in Aeronautics," "Lord Rayleigh on Flight," "The Langley Aerodrome," "The Zeppelin Air Ship," "Progress in Physics in the Nineteenth Century," "Electricity During the Nineteenth Century," etc. Published at the Government Printing Office, Washington.

Personal.

Reuben C. Hallett has accepted a position with the Chicago Pneumatic Tool Company's Eastern sales department.

Obituary.

Henry Morris died in Philadelphia, January 25, forty-two years. Mr. Morris was a son of Henry Morris of the widely known firm of Morris & Tasker. He was connected for some time with the I. P. Morris & Co. Machine Works, of Philadelphia, and was up to his death secretary of the American Pulley Company.

Commercial Review.

New York, Monday, January 27.

THE MACHINERY AND SUPPLY MARKET.

An old-established seller of machinsts' and jewelers' supplies in this city states that never before has he had such an active trade as since the beginning of the present year. While this is by no means a universal experience it is not a surprising one in view of the tone that seems to be prevalent in the mechanical industries.

One of the most interesting items of news to report at present is the closing of contracts for tools by the Mexican National Railway. An amount estimated at $35,000 to $50,000 has just been contracted for, the awards going chiefly, we understand, to different large local machine tool houses. Among the machinery are three 80-inch driving-wheel lathes with quartering attachments. This item alone would probably foot up to about $10,000. There are also three 300-ton wheel presses, some lathes and a variety of other tools. Specifications have just come out for a quantity of tools for a Chilian railway.

A manufacturing company in Pennsylvania having previously placed an order for twenty frog and switch planers of the L. W. Pond Machine Company, Worcester, Mass., has just increased the number to thirty.

Among the latest in combinations is a reported attempt to form a trust in taps, also one in chucks. From what is heard we infer that the former has reached the more definite stage of the two. The names are given of certain New England manufacturers who are talked of as members. There is already, we understand, a price agreement as to pipe taps.

A long list of machine tools required by the Springfield (Mass.) Armory has been issued. Bids will be opened February 12. Among the items are 124 No. 2 Lincoln milling machines; seventeen Pratt & Whitney Company's No. 3 rifling machines; eight No. 1 two-spindle profiling machines; thirty-one No. 2 ditto; twenty-three barrel-turning lathes; ten No. 2 four-spindle drill presses; a quantity of lathes, etc.

The Philadelphia Pneumatic Tool Company has sent us particulars about the new shop it is to build. It writes: "The shop will be one story with a basement 96x130 feet, with side extension for boiler house 24x44 feet. The engine room will be located in the basement, where we expect to install an 80 horse-power engine, together with direct-connected generating unit for lighting, etc. The boiler will be 60 inches by 16 feet, of the return tubular type and we shall have a round, hollow tile, brick chimney 70 feet in hight. The interior construction and roof frame for the building will be of yellow pine with slag roof. The roof will have four large lanterns or skylights extending transversely of the building, thus allowing plenty of light over the entire floor area. The main floor will

be free from partitions except in one corner where the offices are located. . . . We expect to occupy the building not later than May 1 and are installing a considerable number of new machine tools. The shop will be equipped with steam-heating plant, modern toilet arrangements, lockers for the men and everything to make it a complete modern machine shop in every particular."

The New Process Raw Hide Company, Syracuse, N. Y., reports business as very good at the opening of the new year. The company is in receipt of an order from the British Westinghouse Electric & Manufacturing Company for sixty of its New Process Noiseless Pinions for the equipment of the British company's plant. These pinions are to be used on motors for driving machine tools, electric cranes, etc., and are for transmitting from 5 to 40 horse-power. Orders from other sources are coming in fast and the outlook is promising for a good business year.

The business of W. D. Forbes, an old-established machinist of high class and builder of marine engines at Hoboken, N. J., has been made into a stock concern called the W. D. Forbes Company. The principal office is at 1300 Hudson street, Hoboken, and the capital stock is $100,000.

D. G. Gautier & Co., 32 Cliff street, New York, have been given the agency east of Pittsburgh for the Monogahela Iron and Steel Company, manufacturers of charcoal iron and high-grade chains.

P. A. Frasse & Co., 94 Fulton street, New York, have been given the Eastern distributing agency of the Shelby Steel Tube Company, a part of the United States Steel Corporation. A full stock will be carried, ranging from 1-32 to 4 inches outside diameter.

The Chicago Pneumatic Tool Company reports that since their reorganization orders for compressors, pneumatic tools and appliances, including cranes and hoists, received from the 1st to the 15th inst., equal the total December business, which was greater than that of any preceding month. This also includes an order for eighty tools from the Cramp Shipbuilding Company.

CHICAGO MACHINERY MARKET.

Commenting upon the fact that with a portion of his trade collections are now unusually slow, the seller of an article used in all machine shops said that many of the shops, which during the past year or two had been started by young and enterprising mechanics were doing so well and were so crowded with orders that they were putting back into the business every dollar they were making, equipping larger shops, buying new machinery extensively, seeking in every manner to provide for the business that fairly showered upon them. This so absorbed their earnings that current bills were sometimes neglected. It is not meant to be implied that collections as a rule are slow, but so wide is the prevailing activity that where slowness of collections occurs, it needs special explanation and the above seems to fit the case. This machinists' supply man instanced several Chicago shops that were thus growing so rapidly that every pecuniary resource available was utilized in extensions of facilities.

Concerning trade this month in machinists' supplies, there is some divergence of report, but the decided preponderance of statement is that business is excellent—some say never better. The sale of emery wheels is a very fair index of shop activities. The business of the Chicago branch of the Norton Emery Wheel Company was 58 per cent. better in 1901 than in 1900, and January this year is the best month in the experience of this office. Some sellers of emery wheels note that the percentage of large wheels used is increasing, which is perhaps explicable by the greater economy of the larger sizes.

There is also an extremely satisfactory condition of trade in machinists' small tools. This is especially true of the finer grades. The number of machinists who are keeping up with the times in the equipment of their tool boxes is increasing. It is observable by traveling men that large shops have distinct individualities in the way the men buy tools. In some, the machinists are interested in every new appliance that comes out and, if promising, are ready to test the efficiency of the same. And tools are improving so steadily that the "kits" of these progressive machinists are never complete. By the time the assortment seems complete, some improvement appears which makes it desirable to discard an old tool. In other shops the men are content with the tools they used ten or fifteen years ago and show little or no interest in the latest aids to workmanship that may be presented to their attention. It is equally observable, though by a different class of people, that the work turned out by the shops of the latter class of men does not equal that of shops wherein the mechanics are up-to-date.

Quotations.

NEW YORK, Monday, Jan. 27.

Pennsylvania Foundry Pig Iron, Jersey City delivery:

No. 1 X	$17 15 @ $17 65
No. 2 X	16 65 @ 17 15
No. 2 plain	16 15 @ 16 65
Gray forge	15 25 @ 15 75

Alabama Pig, New York delivery:

No. 1 foundry, or soft	16 25 @ 16 50
No. 2 foundry, or soft	15 75 @ 16 00
No. 3 foundry	15 25 @ 15 50
Foundry forge, or No. 4	14 75 @ 15 00

Bar Iron—Base sizes—Refined brands, mill price on dock, 1.73c. in carload lots. Smaller quantities from store, 1.95 @ 2.00c.

Tool Steel—Base sizes—Good standard quality, 7c.; extra grades, 10c. and upward.

Machinery Steel—Base sizes—1.95 @ 2.00c. from store.

Cold Rolled Steel Shafting—Base sizes—From store, 2¼ @ 2½c

Copper—Lake ingot, 11⅛ @ 11¼c.; electrolytic, 11c.; casting, 11c.

Pig Tin—In 5- and 10-ton lots, f. o. b., New York, 24 @ 24½c.

Pig Lead—For wholesale lots, 4.10c., with .02½ @ .05c. extra for carloads.

Spelter—4.30c. for ordinary quality, New York delivery.

Antimony—Hallett's, 8⅛ @ 8¼c.; U. S., 8¼ @ 8½c.; Italian, 7¾ @ 7⅞c.

Lard Oil—Prime City, 79 @ 81c. in wholesale lots.

New Catalogs.

The Pneumatic Crane Company, Pittsburgh, Pa., has sent us a copy of an attractive little pamphlet describing its self-traveling trolleys. Size, 6⅜x3½ inches.

The Standard Welding Company, Cleveland., O., has sent us a price list (3½x6¼ inches) of standard seamless steel rims for bicycles or automobiles, and steel tubing.

The Root & Van Dervoort Engineering Company, East Moline, Ill., publishes a catalog (7¼x4¾ inches) of its gas and gasoline engines, including horizontal, vertical, portable and "Reindeer" types.

"A Modern Method of Steam Saving" is the title of a catalog published by F. J. Gast, 26 Cortlandt street, New York, which describes Gast's asbestos air-cell coverings. Size of page, 3½x6 inches, standard.

The lathes shown in the new catalog of the Lodge & Shipley Machine Tool Company, Cincinnati, O., noticed in the "American Machinist," on page 138, range up to 48 inches swing, instead of 38 inches as we stated.

The Turner, Vaughn & Taylor Company, Cuyahoga Falls, O., sends a pamphlet on chain machinery. Among the machines shown and described are the New Edgecombe foot hammer, the No. 1 lightning winder, No. 1 link cutter. The pamphlet is 5¼x6¾ inches.

We have received from the American Blower Company, Detroit, Mich., their illustrated sectional catalog, No. 135 of "A. B. C." hot blast heaters for the heating and ventilation of public buildings and the drying of materials of all kinds. It is 7⅛x8¾ inches.

The Standard Pneumatic Tool Company, Chicago, Ill. (Paris office at 18 Rue Reaumur), has published a catalog in French, presenting its "Little Giant" pneumatic tools. Several pages are devoted to an illustrated description of their mechanism. The pamphlet is 4¼x7¼ inches.

The Chambersburg (Pa.) Engineering Company has published catalog No. 28, devoted to hydraulic riveters and steam hammers. The latter are shown in the single frame, double frame, single frame guided rod and steam drop hammer types. The pamphlet is 6x9 inches, standard size.

The Lewis Tool Company, 44 Barclay street, New York, has sent us a catalog—No. 6—of patent steel slide bar vises which "do not break." These vises are made in a variety of styles for machinists, wood-workers, etc., and include quick-acting vises. The pamphlet is 6x9⅛ inches.

The American Sheet Steel Company, Battery Park Building, New York, has sent us a book of views of its numerous plants with some of their appliances and operations, con-

taining also price lists of galvanized sheets, tables of sizes and weights, etc. The pamphlet is 9x6 inches, standard size.

Record of Recent Construction, No. 31, of the Baldwin Locomotive Works, Philadelphia, Pa., shows a variety of types of engines built for use in the United States and foreign countries. The latter include Mexico, Ecuador, Spain, New Zealand and South Africa. The pamphlet is 9x6 inches, standard size.

The United Telpherage Company, 20 Broad street, New York, sends a pamphlet describing its system for conveying materials, which is by means of an overhead electric motor trolley. Among other purposes the method is applicable to machine shops and foundries. The frontispiece shows a telpherage system in operation for conveying ashes. Size of pamphlet, 6x9¼ inches.

Manufacturers.

The Monmouth (Ill.) Plow Company has selected a site for a new plant.

The Born Steel Range Company, Cleveland, O., proposes to build a new factory.

A one-story foundry will be built in Newark, N. J., at 59 Downing street, for J. J. Clark.

The Perry County Electric Light, Heat & Power Company, Newport, Pa., will duplicate its plant.

The Detroit (Mich.) Screw Works are looking for larger quarters, having outgrown their plant.

The Lehigh Portland Cement Company is erecting a plant at Mitchell, Ill., which will cost $500,000.

It is rumored that the Vandalia (railroad) Company intends to erect repair shops in Logansport, Ind.

The Penberthy Injector Company, Detroit, Mich., has made plans for a new foundry building, 60x36 feet.

The Syracuse (N. Y.) Lakeside & Baldwinsville Railway has under consideration securing additional power.

The Babcock Brothers' Lumber Company, Johnstown, Pa., has started to build a town and plant in Georgia.

Ground has been broken for the plant of the new Valentine Indurated Fibre Ware Company, Allentown, Pa.

The Cincinnati, Hamilton & Dayton Railroad Company intends to erect new shops at Lima, O., to cost $150,000.

The Wausau (Wis.) Paper Mills Company proposes to erect a 48x150-foot addition, in which will be placed a new machine.

Caspar Ranger, Holyoke, Mass., has been awarded the contract for remodeling the No. 1 mill of the Holyoke Paper Company.

The Amet Engine Company, Waukegan, Ill., will erect a factory to build gas engines under the patent held by E. H. Amet.

Bids will soon be asked for on the proposed extension to the works of the Singer Manufacturing Company, at Elizabeth, N. J.

W. H. Dustin, proprietor of the Eagle Cotton Mills, Lawrenceburg, Tenn., recently destroyed by fire, has decided to rebuild.

The Driver-Harris Wire Company, of 84 Mechanic street, Newark, N. J., is building a factory on Railroad avenue, Harrison.

Preparations are being made to increase the capacity of the shovel works of the Union Shovel Company, Allegheny, Pa.

The Eclipse Manufacturing Company, Pittsburgh, Pa., will increase the capacity of its rivet department by adding new machinery.

The Gorham Manufacturing Company, silverware, Providence, R. I., has bought land on which an addition to the works will be built.

John N. Stearns & Co., New York city, manufacturers of silk, will erect dye works in Williamsport, Pa. The buildings will be 600x450 feet.

The Liberty Manufacturing Company, Center avenue, Pittsburgh, Pa., contemplates some improvements to its plant and will add more machinery.

The top works and about all the valuable machinery of the coal mine of Heaps Bros., Boone, Ia., have been destroyed by fire. It is expected to rebuild.

Walter H. Bruen has purchased property in Jersey street, Harrison, N. J., 50 feet east of Second street, and will erect a factory for making brass goods.

The Fischer Foundry & Machine Company, builder of steam engines, etc., Pittsburgh, Pa., has just bought a quantity of real estate in that city, at $90,000.

Thomas L. Noble, of Jenkintown, Pa., has organized a company to be known as the Abington Brick Company, and will open up a brick yard near Weldon.

The Waldo Smelting & Mining Company, recently incorporated, will, it is believed, build a plant near Colorado City, Colo., at a cost of about $1,000,000.

Plans have been prepared for a foundry with core-room and cleaning room attached for the Detroit Lubricator Company, Detroit, Mich. It will be 70x162 feet.

Plans for the new blast furnace for the Rochester & Pittsburgh Coal & Iron Company, at Dubois, Pa., are being prepared by Julian Kennedy, Pittsburgh, Pa.

The American Supply Company, with a capital stock of $50,000, doing business in a number of oil fields, proposes to move its shops from Scio, O., to Marietta.

The Niles Boiler Company, Niles, O., has just completed and shipped a tank to Marcus Hook, near Chester, Pa., which is said to be the largest oil tank ever constructed.

It is proposed to rebuild on an enlarged scale the St. Francis Mills, owned by the Canada Paper Company, Ltd., of Montreal, and which were destroyed by fire last year.

The American Machine & Manufacturing Company, Ravenna, O., has been organized and will operate a plant to manufacture a full line of clay and brick machinery, etc.

The Opelousas (La.) Compress Company has purchased the building and property known as the National rice mill, it being their purpose to erect a new and modern compress.

According to the latest plans a factory for the manufacture of street cars, to cover 40 acres of land, will be built at Wayne, Ill., by the Elgin, Aurora & Southern Traction Company.

The Western Cartridge Company, of East Alton, Ill., has started work on a factory for metallic cartridges, a new department. Two new buildings for this department will be erected.

The Chandler Wire Fence Company, Trenton, N. J., is said to be looking for a site on which to build a branch plant. Ground at Wheeling, W. Va., is said to be under consideration.

The large paper mill belonging to Harry J. Pierson, of Lambertville, N. J., located at Ingham Springs, near New Hope, Pa., which was destroyed by fire recently, will be rebuilt at once.

Nimmons & Fellows, Chicago, Ill., have made plans for a machine shop, 200 feet square, to be built for the plant of the Berlin Machine Company, at Beloit, Wis., at a cost of $50,000.

The Redding Engineering Company has started its new plant in Pittsburgh, Pa., making a line of steam pumps, etc. The plant consists of a brass foundry, machine shop and foundry.

Plans have been made for a factory building to be erected at Twenty-second and Johnson streets, Chicago, Ill., for the Kinsella Glass Company. It will be two-story, 145x100 feet, and cost $40,000.

The Uehling-Steinbart Company, of Carlstadt, N. J., has purchased twenty lots at Passaic, and will soon give out contracts for a three-story brick building for the manufacture of scientific instruments.

Samuel O'Neil & Sons, of Pittsburgh, Pa., have purchased land near Beaver Falls, where they will put up a brick plant. It will be under the supervision of C. L. French and R. H. Wilson, of New York.

The Fenton & Spaulding Box Company, Tonawanda, N. Y., is planning to make alterations, among which will be the enlargement of the box factory and the installation of much new and modern machinery.

A new paper mill at Ausable Forks, N. Y., to cost from $150,000 to $200,000, will probably be put up in the spring by the J. J. Rogers Company. Manila wrapping paper will be the chief product of the mill.

J. E. & A. L. Pennock, builders, Philadelphia, Pa., are taking sub-bids for a tool shop for the Philadelphia Pneumatic Tool Company at Twenty-first and Lippincott streets. Plans are by Walter Smedley, architect.

The stockholders of the Reed Manufacturing Company, manufacturer of anti-rust tinware, Newark, N. Y., have decided to increase the capital stock from $75,000 to $150,000. An addition will be made to the buildings.

A foundry building is to be erected for the Johnson & Jennings Company, founders and manufacturers of sash weights, Cleveland, O. A number of other new buildings for the same plant are being pushed to completion.

After some delay, caused by the difficulty in making contracts for mill structure and machinery, ground has been broken for the ten-mill sheet plant of the Rolling Mill Company of America at South Connellsville, Pa.

Architect Louis Kamper, Detroit, Mich., has prepared plans for a factory building for Hugo Scherer & Co. for the manufacture of steel boats. It will be 200x80 feet. There will also be a brick power-house, 32x40 feet.

The Canadian Pacific Railway has plans for new shops at Montreal or elsewhere in the East. It is said that on these and connected interests the road is prepared to spend $2,000,000, but that nothing has yet been definitely decided.

R. S. Warner, who recently retired from the presidency of the Republic Iron & Steel Company, is at the head of a company which will build a plant in Columbus, O., for the manufacture of steel and malleable castings and other iron and steel products.

The Union Pacific Railway is beginning work on shops at Omaha, Neb., on which it expects to spend $750,000 this year. Many of the contracts are already let, among them those for the tools and for other portions of the stationary machinery equipment.

The Moline Plow Company, Moline, Ill., will erect a new six-story building. The first story will be used for a new blacksmith shop, the second for the erecting department, the third for the paint department and the top three floors as warehouse rooms.

The Arkansas Lumber Company has contracted with the D. J. Murray Manufactur-

ing Company, sawmill machinery, Wausau, Wis., for a double band and gang mill to be erected at Malvern, Ark. The cost will exceed $100,000. The capacity will be 300,000 feet a day.

Thomas H. Tracy, president of the Toledo (O.) Railway & Terminal Company, has announced that a contract has just been closed whereby a company of outside capitalists will construct a blast furnace plant in that city, which is to cost $1,000,000 and employ about 500 men.

The Pontiac Turning Company has been formed at Pontiac, Mich. The capital stock is fixed at $20,000 and the contract has been let for the construction of the factory. The board of directors consists of A. L. Moore, H. C. Kudner, George S. Axford, L. W. Nichols and R. F. Monroe.

The 175x150-foot, two-story building of the St. Louis Iron & Steel Foundry Company, at Eighth and Hickory streets, St. Louis, Mo., has been destroyed by fire. It will be rebuilt. Besides the steel works, the plant of the Rice Coil Spring Company was destroyed, with a loss of $2,000.

The Louisbourgh Talc Company has been incorporated in Maine, largely by New Haven, Conn., men. It proposes to develop mining property in Cape Breton and to build a plant at New Haven for milling the mineral. Harry Hurd, a lumber dealer, of New Haven, will act as manager of the company.

John J. Turner, of Amsterdam, N. Y., and the American Bridge Company have been awarded a contract by the Fonda, Johnstown & Gloversville Railway Company to erect a power-house east of Tribes Hill. The building, it is stated, will cost $500,000, which presumably must include the equipment.

Harry Kuemmerle, builder, Betz Building, Philadelphia, Pa., has received plans from William H. Brown, chief engineer of the Pennsylvania Railroad Company, and has invited sub-bids for a power station on Federal street, Camden, for the railroad company. It will be a 2½-story building, 150x100 feet.

A party of Illinois men have formed a company to erect a 1,500-barrel rice mill at Roanoke, six miles west of Jennings, La. Among those interested are R. C. Augustine, optician, Decatur, Ill.; John R. Rogers, with National Bank of Decatur; Frank L. Suffern, formerly with Suffern & Hunt Cereal Mills, Decatur.

The American Can Company has broken ground for the enlargement of its plant near Woodland Park, Ludlow, Ky. The concern employs 150 hands and has a capacity of 4,000,000 tobacco tags per day. Under the new arrangement the number of employees will be doubled as will the average daily output of tobacco tags.

The Central Foundry & Machine Company, Inc., Reading, Pa., has consolidated with the National Tool & Machine Company, of that city. The capital stock has been increased from $7,000 to $18,000. The company will do a general line of machine work, with specialties including scales, speed lathes, slide rests and many other things.

About $50,000 is to be spent by the Hollidaysburg (Pa.) Iron & Nail Company in improvements to the rolling mill. A new finishing mill, 100x200 feet, will be built, containing four heating furnaces, the bar and guide mills, nail plate mill, engines, shears, straightening beds, etc. Twenty new puddling furnaces will be added.

A large milling plant is to be built in Philadelphia, Pa., at Delaware avenue and Green street by the East Coast Milling Company, a new incorporated concern composed of Philadelphia and New York capitalists. The syndicate has a capital of $9,000,000, and has acquired property from Alexander Kerr, Bro. & Co., salt importers.

The Kenyon Paper Company, of Baldwinsville, N. Y., has just completed an addition to its plant located on Seneca River, at a cost of $40,000. The company has just acquired new property on the river with a capacity of 1,000 horse-power, and has under consideration the expenditure of between $75,000 and $100,000 in improving the property early this year.

A power-house is to be erected at Collegeville, Pa., for the Schuylkill Valley Traction Company. This company recently leased the Trappe & Limerick Electric Railway Company and the Chestnut Hill & Norristown Electric Railway Company for a period of 950 years. The lines will be merged into one company, with the center of operation at Norristown.

A corporation known as the Safety Explosive Company of America has bought 245 acres near Salem, N. J., and will erect a large plant for manufacturing blasting powder and other explosives from corn gluten. The names of two Philadelphians are mentioned in connection with the project—that of A. A. Harris as president and Henry A. Ingram as treasurer.

The Norfolk & Western Railroad Company has placed another order for new equipment. It calls for thirty locomotives of the largest class in use on the line, which has proved satisfactory in hauling heavy coal trains over the mountain divisions of the road. Fifteen of these are to come from the Baldwin Locomotive Works, and the remaining fifteen from the Richmond Locomotive Works.

The Vigo Bridge Manufacturing & Supply Company has been organized at Terre Haute, Ind. G. A. Conzman is president and John L. Walsh secretary-treasurer. The object of the company is to build bridges and manufacture school furniture, road scrapers and other tools used by road contractors. It is the intention to build a plant in Terre Haute in the near future.

Steinway & Sons, piano manufacturers, have sold their large property at Fifty-third street and Park avenue, New York city, where their factory was located to the New York Central Railroad. The new factory building at Steinway is making rapid progress. It is expected that the transfer of the entire manufacturing plant from Manhattan will be made early in the spring.

The Davis, Walker & Cooper Company has been organized at Youngstown, O. It is not unlikely that the works will be located at Warren or Hubbard. The officers are as follows: President, C. L. Walker; vice-president and general manager, James Cooper; secretary and treasurer, Evan J. Davis. The company will manufacture general mechanical engineering work, making a specialty of rolling mill and furnace work. Its offices and present plant are on Decker street, Youngstown.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Gear Wheels, gear cutting. Grant; see p. 18.

Punches & dies. Wal.M.Wks.,Waltham,Mass.

Stamping dies. Emmons Collins, Chicago.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Fine machine and experimental work. The Des Jardins Type Justifier Co., Hartford, Ct.

Light and fine mach'y to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Wanted—Improvements in grinding machinery. Address Box 1435, Providence, R. I.

Wanted—Old style screw planer, not less than 42 inches wide. The Highland Machine Co., Boston, Mass.

Special tools, models, fine light mach'y and foundry work wanted. Murray Mfg. Co., Richmond Valley, Staten Island, N. Y.

For Sale—Draper lathe, 24-32 in. by 14 feet, compound rest, 24 in. chuck; practically brand new. Rushmore Dynamo Works, Jersey City.

Purchaser for small manufacturing plant; lot, 100x180 feet; machine shop, 32x68, two story, with line shaft and gasoline power; foundry, 40x54, new modern equipment; good location; for sale cheap. Hart-Parr Co., Charles City, Iowa.

Foundry in eastern Pennsylvania, making a specialty of machinery castings, would like to make contract with machinery manufacturing concern for furnishing strictly high-grade castings at lowest figure. Address "Foundry," care AMERICAN MACHINIST.

A party with capital and experience desires to purchase a part, or the entire interest in a mechanical manufacturing plant near New York; full investigation required; references exchanged; principals only apply. Cornelius S. Loder, 271 Broadway, New York.

Institutions retiring from business having machine tools, brass and wood working machinery will find it to their interest to correspond with us. We purchase complete plants or handle them on com. C. C. Wormer Mach. Co., 55-59 Woodbridge st., W., Detroit, Mich.

A thorough machinist, with good shop located in southwestern Ohio, would like to correspond with the object of making permanent contract to build medium-weight machinery; those having established trade preferred. Address Box 117, AMER. MACHINIST.

Shrinkage of the pitch of screws or taps in hardening can be very successfully overcome by using my new screw-cutting device; it eliminates errors in the lead screw; is practical, positive, and quicker to operate than anything in the market. Address for particulars John Grime, 1709 South Seventh St., Minneapolis, Minn.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded; but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents.

Situations Wanted.

Practical mechanical draftsman wishes position. Box 16, AMERICAN MACHINIST.

Competent machine shop or toolroom foreman desires change. Box 76, AMER. MACH.

Experienced draftsman wants position on good class of work. Box 118, AMER. MACH.

Practical machine tool salesman wishes position, to travel. Box 110, AMER. MACH.

Gas engine expert wishes position; salesman or superintendent. Box 111, AM. MACH.

Mechanical draftsman and designer, competent to manage drawing room. Box 75, AMERICAN MACHINIST.

Practical, systematic machine shop foreman wants position; splendid references. Box 94, AMERICAN MACHINIST.

Mechanical draftsman, experienced designer, wishes position near New York city. Box 95, AMERICAN MACHINIST.

Practical foreman machinist desires change; well up in gear cutting and general machinery. Box 108, AMERICAN MACHINIST.

First-class machinist; assembling and testing gasoline motors; experimenting and forging; A1 references. Box 113, AMER. MACH.

A practical superintendent or general foreman of 20 years experience on high-speed and Corliss engine and mill work. Address R. J. S., care AMERICAN MACHINIST.

A practical, experienced machine shop foreman wants position where energy and ability are wanted; Middle States preferred. Address Box 81, AMERICAN MACHINIST.

Head draftsman, 6 years' experience in textile work and power transmission, wishes position as assistant superintendent; references. Box 103, AMERICAN MACHINIST.

An erecting engineer, 25 years' experience

with general machinery, desires position as master mechanic of mill or factory; best references given. Box 107, AMER. MACH.

Designing draftsman desires permanent position with progressive firm; 12 years' experience; well up in all details of modern shop practice. Box 53, AMER. MACHINIST.

Position in Greater New York or vicinity, as chief draftsman, designer or assistant to superintendent; on fixtures, light automatic and paper working machinery. Box 112, A. M.

Practical machine designer, technical graduate with shop knowledge, 10 years' experience intricate automatic machinery and tools, light and heavy, wishes to change. Box 51, AMERICAN MACHINIST.

By young man; 3 years machinist, 8 years draftsman and designer on machine tools, 3 years charge of manufacture of light machinery; New York city or vicinity preferred. Box 109, AMERICAN MACHINIST.

Mechanical engineer, who had leading positions in the gas engine line for marine and carriages in Europe and United States, wishes responsible position or to correspond with parties who intend to build a new motor. Box 119, AMERICAN MACHINIST.

An engineer, well up in steam and mechanical engineering, desires position as a salesman and constructing engineer for a reliable firm of manufacturers; capable, energetic, all-round man; traveled West and East; best references. Address Box 114, A. M.

Mechanical engineer, 42, married, practical, inventive, accurate designer, wide experience, constructing and erecting heavy and intricate machinery in large factories and at the Paris Exposition, seeks permanent position with progressive firm; A1 references. Box 102, AMERICAN MACHINIST.

Cost Clerk—Accountant desires immediate change; expert in details of manufacturing; practical shop experience; a hustler, linguist, thoroughly familiar with double entry bookkeeping and all office details; highest reference from present employer; expectations moderate. Box 116, AMERICAN MACHINIST.

Help Wanted.

Toolmakers wanted. Sun Electric Mfg. Co., Westchester, Pa.

Wanted—Two experienced patternmakers for Colorado; wages 30 cents per hour. Address Box 105, AMERICAN MACHINIST.

Wanted—First-class tool and die makers. Address Box 99, AMERICAN MACHINIST.

Wanted—Engineer capable of testing and selling pumping engines; state experience and salary. Box 89, AMERICAN MACHINIST.

Draftsman—Young man, not over 21, in machine shop, also to assist in shop accounting; wages $12. Durbrow & Hearne Mfg. Co., 8, 10 and 12 Wooster St., New York.

Three machine tool foremen, two erection foremen and two inspectors used to heavy machine work. Box 115, AMER. MACHINIST.

Wanted—Chicago advertising representative for New York technical weekly; give references and experience. Address H., care AMERICAN MACHINIST.

Wanted—Number of patternmakers, experienced on compressor or steam engine work; none others need apply. Franklin Air-Compressor Co., Franklin, Pa.

Wanted—Five experienced machinists for Colorado, to run tools, boring mill, planer and lathes; wages 30 cents per hour. Address Box 106, AMERICAN MACHINIST.

Wanted—By Struthers, Wells & Co., of Warren, Pa., experienced draftsmen to work on gas engine drawings; write at once for particulars, stating age and experience.

A firm located about 100 miles from New York, desires to secure the services of a competent mechanical draftsman; applicants will please give full particulars. Box 98, AM. M.

New York city; general machinist on quite heavy machinery; young man; experienced, progressive and A1 mechanic; a special responsible position to such only. Box 87, A. M.

Young man, technical graduate, steam or mechanical course, for general testing and engineering work; give references and state salary expected. Box 96, AMERICAN MACHINIST.

Mechanics, engineers, electricians, firemen, etc. A free scholarship in engineering will be awarded to a few well-recommended applicants. American School of Correspondence, Boston, Mass.

Wanted—A draftsman familiar with turret machine practice; capable of designing tools for cast iron work; shop located in a small N. E. town; permanent position. Box 97, AMERICAN MACHINIST.

Wanted—Mechanical draftsman with first-class experience on general machinery, preferably in steel works; state age, experience, reference and salary expected. Address P. O. Box 1042, Philadelphia, Pa.

Wanted—First-class machine shop foreman for New England shop employing 30 men; work is general transmission of power machinery and repairing; only experienced men need apply. Address W., care AM. M.

Wanted—A good machinist who can take charge of machine shop in a bridge works and who understands electrical repair work. Address "A.," care AMERICAN MACHINIST, giving experience, recommendations and wages expected.

We are enlarging our works, and will shortly require an increased number of skilled mechanics; we invite application from pattern makers, molders and machinists. Address the Westinghouse Machine Company, East Pittsburgh, Pa.

Draftsmen, experienced in structural and mechanical engineering in connection with elevator and crane work; good salaries and permanent positions to the right men; give record, stating experience and salary expected. Box 101, AMERICAN MACHINIST.

Wanted—Thoroughly competent foreman for brass foundry, experienced in making brass valves and fittings, familiar with molding machinery and mixing of metals; state age, experience, salary expected and references. Box 104, AMERICAN MACHINIST.

Wanted—Foreman and layer-out in a contract boiler shop employing 25 men; capable of laying out all kinds of boiler and tank work and experienced in handling men; give age, experience and wages wanted. Address "Cincinnati Boiler Maker," care AM. MACH.

Wanted—Thoroughly competent foreman on machine tool building, experienced in building pipe threading machinery, familiar with methods of producing duplicate parts on turret lathes; give age, experience, salary expected and references. Box 28, AMER. MACH.

Wanted—Draftsmen: one skilled man to lay out work from sketches on complicated small automatic machinery; two for general drawing and expert detailing; all must be acquainted with modern machine shop practice. Address, giving experience, etc., "Automatic," Box 23, Gen. P. O., New York.

A machine tool-building concern near Manchester, England, wants a man with experience in machine tool construction to act as inspector, to inspect the work as it goes through the shop and also the machines when finished; shop is of modern construction and doing high-grade work. Address Box 100, AMERICAN MACHINIST.

We are erecting new shop buildings and equipping same with all modern appliances; will shortly require an increased number of skilled mechanics; we invite application from machinists, boilermakers and patternmakers; good references must be furnished as to ability and habits. Address Southern Engine & Boiler Works, Jackson, Tenn.

Wanted—Boiler shop foreman, capable of taking charge of shop working from 75 to 100 men at present and will build new plant during the coming year; must have experience in construction of locomotive boilers and tank work, also the use of hydraulic and air tool equipment of the latest design; a first-class position for the proper party. Address "Locomotive Works," care AMERICAN MACHINIST.

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Gould & Eberhardt, Newark, N. J.
Harrington & Son Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Niles Tool Works, New York.
New Haven Mfg. Co., New Haven, Conn.
Prentice Bros. Co., Worcester, Mass.
Sibley & Ware, South Bend, Ind.

Drills, Center
Slocomb & Co., J. T., Providence, R. I.

Drills, Rail
Bement, Miles & Co., New York.
Flather & Co., Nashua, N. H.
Niles Tool Works, New York.

Drills, Ratchet
Parker Co., Chas., Meriden, Ct.

Dynamos
C & C Electric Co., New York.
Crocker-Wheeler Electric Co., Ampere, N. J.
Eddy Elec. Co., Windsor, Conn.
General Elec. Co., New York.
Jantz & Leist Elec. Co., Cincin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Robbins & Myer Co., Springfield, O.
Sprague Elec. Co., New York.
Triumph Elec. Co., Cincinnati, O.
Western Elec. Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electrical Supplies
General Elec. Co., New York.
General Incan. Arc Light Co., New York.
Triumph Electric Co., Cincin., O.
Western Elec. Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.

Elevators
Albro-Clem Elevator Co., Philadelphia, Pa.
Morse, Williams & Co., Phila., Pa.
Whiting Fdry. Equipment Co., Harvey, Ill.

Emery Wheels
See Grinding Wheels.

Enclosures, Tool-room
Merritt & Co., Philadelphia, Pa.

Engines, Automobile
Franklin Mfg. Co., Syracuse, N. Y.

Engines, Gas and Gasoline
Backus Water Motor Co., Newark, N. J.
Columbus Mach. Co., Columbus, O.
Foos Gas Eng. Co., Springfield, O.
Mietz, August, New York.
Monarch Gas Engine Co., Indianapolis, Ind.
New Era Iron Wks., Dayton, O.
Olds Motor Wks., Detroit, Mich.
Patterson, Gottfried & Hunter, Ltd., New York.
Regal Gas Engine Co., Coldwater, Mich.
Springfield Gas Eng. Co., Springfield, O.
Struthers, Wells & Co., Warren, Pa.
Weber Gas & Gasoline Eng. Co., Kansas City, Mo.

Engines, Steam
Buffalo Forge Co., Buffalo, N. Y.
Frick Co., Waynesboro, Pa.
Rand Drill Co., New York.

Fans, Exhaust
Buffalo Forge Co., Buffalo, N. Y.

Fans, Electric
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Elec. Co., New York.
Western Elec. Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.

Files and Rasps
Barnett Co., G. & H., Phila., Pa.
Hammacher, Schlemmer & Co., New York.
Nicholson File Co., Prov., R. I.

Fillers, Oil Can
The Winkley Co., Hartford, Conn.

Fittings, Steam
Crane Co., Chicago, Ill.
Crosby Steam Gage & Valve Co., Boston, Mass.
Jenkins Bros., New York.
Lunkenheimer Co., Cincinnati, O.
Walworth Mfg. Co., Boston, Mass.

Forges
Buffalo Forge Co., Buffalo, N. Y.

Forgings, Drop
Billings & Spencer Co., Hartford, Conn.
Williams & Co., J. H., Brooklyn, N. Y.
Wyman & Gordon, Worcester, Mass.

Forgings, Hydraulic
Wyman & Gordon, Worcester, Mass.

Foundry Furnishings
Obermayer Co., S., Cincinnati, O.
Whiting Foundry Equip Co., Harvey, Ill.

Furnaces, Coal, Gas and Oil
Am. Gas Furnace Co., N. Y. City.

Gages, Recording
Bristol Co., Bridgeport, Conn.

Gages, Standard
Brown & Sharpe Mfg. Co., Providence, R. I.
Pratt & Whitney Co., Hartford, Ct.
Rogers, John M., Boat, Gage & Drill Works, Gloucester City, N. J.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb & Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Gages, Steam
Crosby Steam Gage & Valve Co., Boston, Mass.

Gas Producers
Am. Gas Furnace Co., N. Y. City

Gear Cutting Machinery
Bickford Drill & Tool Co., Cin., O
Brown & Sharpe Mfg. Co., Providence, R. I.
Fellows Gear Shaper Co., Springfield, Vt.
Gleason Tool Co., Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington & Son Co., Edwin, Philadelphia, Pa.
Newton Mch. Tool Wks., Phil., Pa.
Niles Tool Works, New York.
Pratt & Whitney Co., Hartford, Conn.

Gears, Cut
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Wks., Boston, Mass
Cleveland Gear Wks., Cleveland, O.
Fawcus Mach. Co., Pittsburgh, Pa.
Gleason Tool Co., Rochester, N. Y
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott, Cleveland, O.
New Process Raw Hide Co., Syracuse, N. Y.
N. Y. Gear Works, Brooklyn, N. Y.
Nuttall Co., R. D., Pittsburgh, Pa.

Gears Molded
Farrel Fdry & Mch. Co., Ansonia, Conn.
Greenwald Co., I. & E., Cincin., O.
Poole & Son Co., Robt., Baltimore, Md.

Gears, Rawhide
Chicago Raw Hide Co., Chicago, Il
New Process Raw Hide Co., Syracuse, N. Y.

Graphite
Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Center
Heald & Son, L. S., Barre, Mass.
Leland & Faulconer Mfg. Co., Detroit, Mich.

Grinders, Cock
Windsor Mach. Co., Windsor, Vt.

Grinder, Cutter
Adams Co., Dubuque, Iowa.
Cincinnati Milling Mach. Co., Cincinnati, O.
Garvin Mach. Co., New York.
Gould & Eberhardt, Newark, N. J.
Modern Tool Co., Erie, Pa.
Norton Emery Wheel Co., Worcester, Mass.
Rivett-Dock Co., Boston, Mass.

Grinders, Disc
Gorton Mach. Co., Geo., Racine, Wis.
Ransom Mfg. Co., Oshkosh, Wis.
Universal Mach. Co., Provi., R. I.

Grinders, Drill
Gorton Mach. Co., Geo., Racine, Wis.
Heald & Son, L. S., Barre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Saw
Keystone Mach. Tool Co., Philadelphia, Pa.

Grinders, Tool
Anderson Tool Co., Anderson, Ind.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Gisholt Mach. Co., Madison, Wis.
Landis Tool Co., Waynesboro, Pa.
Leland & Faulconer Mfg. Co., Detroit, Mich.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, O.
Whitney Mfg. Co., Hartford, Ct.

Grinding Machines
Anderson Tool Co., Anderson, Ind.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders' Iron Foundry, Providence, R. I.
Gorton Mach. Co., Geo., Racine, Wis.
Hill, Clarke & Co., Boston, Mass.
Landis Tool Co., Waynesboro, Pa.
Northern Elec. Mfg. Co., Madison, Wis.
Norton Emery Wheel Co., Worcester, Mass.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, Mass.
Universal Mach. Co., Provi., R. I.
Webster & Perks Tool Co., Springfield, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding Wheels
Abrasive Material Co., Phila., Pa.
Builders' Iron Foundry, Providence, R. I.
Carborundum Co., Niagara Falls, N. Y.
Hampden Cor. Wheel Co., Brightwood, Mass.
Norton Emery Wheel Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.

Gun Barrel Machinery
Bement, Miles & Co., New York.
Niles Tool Works, New York.
Pond Mach. Tool Co., New York.
Pratt & Whitney Co., Hartford, Ct.
Reed Co., F. E., Worcester, Mass.

Hack Saw Blades and Frames
Millers Falls Co., New York.
Starrett Co., L. S., Athol, Mass.
West Haven Mfg. Co., New Haven, Conn.

Hack Saws, Power
Hoefer Mfg. Co., Freeport, Ill.
Millers Falls Co., New York.

Hammers, Drop
Bement, Miles & Co., New York.
Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Merrell Bros., Brooklyn, N. Y.
Perkins Mach. Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Ct.

Hammers, Pneumatic
Cleveland Pneumatic Tool Co., Cleveland, O.
Dallett & Co., Thos. H., Phila., Pa.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Standard Pneumatic Tool Co., Aurora, Ill.

Hammers, Steam
Bement, Miles & Co., New York.
Chambersburg Engineering Co., Chambersburg, Pa.
Cleveland Punch & Shear Wks Co., Cleveland, O.
Crawshaw & Judd, Worcester, Mass.

Handles, Machine Tool
Schacht Mfg. Co., Cincinnati, O.

Heating Machines, Automatic
Am. Gas Furnace Co., 23 John st., N. Y. City.

Heating and Ventilating Apparatus
Buffalo Forge Co., Buffalo, N. Y.

Hoists, Electric
C & C Electric Co., New York.
Hunt Co., C. W., West New Brighton, N. Y.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger, Milwaukee, Wis.

Hoists, Hand
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic
Cleveland Pneumatic Tool Co., Cleveland, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Northern Engineering Wks., Detroit, Mich.
Rand Drill Co., New York.
Standard Pneumatic Tool Co., Aurora, Ill.
Whiting Fdry. Equipment Co., Harvey, Ill.

Hoisting and Conveying Machinery
Brown Hoisting Mchry. Co., New York.
Caldwell & Son Co., H. W., Chicago, Ill.
Hunt Co., C. W., West New Brighton, N. Y.
Link Belt Engineering Co., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.

Indicators, Steam
Crosby Steam Gage & Valve Co., Boston, Mass.

Injectors
Lunkenheimer Co., Cincinnati, O.
Sellers & Co., Wm., Phila., Pa.

Inspection and Tests
Hunt Co., Robt. W., Chicago, Ill.

Instruction Schools
See Schools, Correspondence.

Instruments, Drawing
Alteneder & Son, Theo., Philadelphia, Pa.

Insurance, Boiler
Hartford Steam Boiler Insp. & Ins. Co., Hartford, Conn.

Jacks, Hydraulic
Watson-Stillman Co., New York.

Joints, Universal
Baush Machine Tool Co., Springfield, Mass.

Key Seaters
Baker Bros., Toledo, O.
Bement, Miles & Co., New York.
Chattanooga Mchy. Co., Chattanooga, Tenn.
Mitts & Merrill, Saginaw, Mich.

Keys, Machine
Standard Gage Steel Co., Beaver Falls, Pa.
Whitney Mfg. Co., Hartford, Ct.

Lamps, Arc
General Electric Co., N. Y City.
Gen. Incan. Arc Light Co., N. Y.
Lea Elec. Mfg. Co., Anderson, Ind.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.

Lathes, Bench
Faneuil Watch Tool Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Ct.

Lathe Dogs
Armstrong Bros. Tool Co., Chicago, Ill.
Le Count, Wm. G., So. Norwalk, Conn.

Lathe Feed
Nat'l. Mach. Tool Co., Cincin., O.

Lathes
American Tool Wks. Co., Cin., O.
Automatic Mach. Co., Bridgeport, Conn.
Baird Machy. Co., U., Pittsburgh, Pa.
Barker & Chard Mach. T. Co., Cincinnati, O.
Barnes Co., B. F., Rockford, Ill.
Barnes, W. F. & John, Rockford, Ill.
Bement, Miles & Co., New York.
Blaisdell & Co., P., Worcester, Mass.
Bradford Mach. Tool Co., Cin., O.
Bullard Mach. Tool Co., Bridgeport, Conn.
Fairbanks Mach. Tool Co., Springfield, O.
Flather Planer Co., Mark, Nashua, N. H.
Garvin Mach. Co., New York.
Grant Tool Co., Franklin, Pa.
Harrington, Son & Co., Edwin., Philadelphia, Pa.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
McCabe, J. J., New York.
New Haven Mfg. Co., New Haven, Conn.
Niles Tool Works, New York.
Pond Mach. Tool Co., New York.
Prentice Bros. Co., Worcester, Mass.
Reed Co., F. E., Worcester, Mass.
Schumacher & Boye, Cincinnati, O.
Sebastian Lathe Co., Cincin., O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Letters, Pattern
Butler, A. G., N. Y. City.

Levels
Starrett Co., L. S., Athol, Mass.

Lockers, Clothes
Merritt & Co., Philadelphia, Pa.

Locomotives, Shop
Hunt Co., C. W., West New Brighton, N. Y.

Lubricants
Dixon Crucible Co., Jos., Jersey City, N. J.

Lubricators
Bowen Mfg. Co., Auburn, N. Y.
Lunkenheimer Co., Cincinnati, O.

Machinists' Small Tools
Billings & Spencer Co., Hartford, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hammacher, Schlemmer & Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Ct.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb & Co., J. T., Provi., R. I.
Standard Tool Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.

Machinery Builders, Special
American Fdry Mach. Co., Hanover, Pa.
Blanchard Mach. Co., The, Boston, Mass.
Watson Mach. Co., Paterson, N. J.

Machine Screws
Worcester Mach. Screw Co., Worcester, Mass.

Mandrels, Expanding
Nicholson & Son, W. H., Wilkesbarre, Pa.

Mandrels, Solid
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Rogers, John M., Boat, Gage & Drill Works, Gloucester City, N. J.

Measuring Machines
Pratt & Whitney Co., Hartford, Ct.
Rogers, John M., Boat, Gage & Drill Works, Gloucester City, N. J.

Micrometer Calipers
Brown & Sharpe Mfg. Co., Providence, R. I.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb & Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Milling Attachments
The Adams Co., Dubuque, Iowa.
Cincinnati Milling Mach. Co., Cincinnati, O.
Kempsmith Mfg. Co., Milwaukee, Wis.

Milling Machines, Bench
Faneuil Watch Tool Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Ct.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Horizontal
Adams Co., Dubuque, Iowa.
Beaman & Smith Co., Provi., R. I.
Bement, Miles & Co., New York.
Franklin Mach. Wks., Phila., Pa.
Grant Tool Wks., Franklin, Pa.
Hendey Mach. Co., Torrington, Ct.
Ingersoll Mill. Mach. Co., Rockford, Ill.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles Tool Works, New York.

Milling Machines, Plain
American Tool Wks. Co., Cin., O.
Aurora Tool Wks., Aurora, Ind.
Bement, Miles & Co., New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mach. Co., Cincinnati, O.
Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Kempsmith Mfg. Co., Milwaukee, Wis.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Pratt & Whitney Co., Hartford, Conn.
Whitney Mfg. Co., Hartford, Ct.

Milling Machines, Portable
Underwood & Co., H. B., Philadelphia, Pa.

Milling Machines, Universal
Amer. Tool Wks. Co., Cincin., O.
Aurora Tool Wks., Aurora, Ind.
Bement, Miles & Co., New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mach. Co., Cincinnati, O.
Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Kempsmith Mfg. Co., Milwaukee, Wis.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Niles Tool Works, New York.
Pratt & Whitney Co., Hartford, Ct.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Vertical
Bement, Miles & Co., New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Garvin Mach. Co., New York.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles Tool Works, New York.

Molding Machines
The Adams Co., Dubuque, Iowa.
Tabor Mfg. Co., Philadelphia, Pa.
Webster & Perks Tool Co., Springfield, O.

Motors, Electric
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Eddy Elec. Mfg. Co., Windsor, Ct.
General Electric Co., New York.
General Incan. Arc Light Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Robbins & Myers Co., Springfield, Ohio.
Sprague Electric Co., New York.
Triumph Elec. Co., Cincinnati, O.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.

Nut Tappers
See Bolt and Nut Machinery.

Oilers
Bay State Stamping Co., Worcester, Mass.

Oil Cups and Covers
Bowen Mfg. Co., Auburn, N. Y.
Crane Co., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
The Winkley Co., Hartford, Conn.

Packing, Steam Joint
Jenkins Bros., New York.

Patterns, Wood
Gobeille Pattern Co., Cleveland, O.

Patent Solicitors
Anderson & Co., E. W., Washington, D. C.
Baldwin, Davidson & Wight, Washington, D. C.
Bevans, James W., Washington, D. C.
Copp & Co., Washington, D. C.
Cromwell, W. H., Washington, D. C.

Pattern Shop Machinery
American Machinery Co., Grand Rapids, Mich.
Baker Bros., Toledo, O.
Fay & Scott, Dexter, Me.
Phosphor Bronze Smelting Co., Philadelphia, Pa.

Pipe Cutting and Threading Machines
Curtis & Curtis Co., Bridgeport, Conn.
Merrell Mfg. Co., Toledo, O.
Saunders' Sons, D., Yonkers, N. Y.

Pipe Fitters' Tools
Saunders' Sons, D., Yonkers, N. Y.
Standard Tool Co., Cleveland, O.

Pipe and Fittings
Crane Co., Chicago, Ill.

Planer, Jack
Armstrong Bros. Tool Co., Chicago, Ill.

Planers
Amer. Tool Wks. Co., Cincin., O.
Belmer-Eames Tool Co., Cin., O.
Bement, Miles & Co., New York.
Betts Mach. Co., Wilmington, Del.
Cincinnati Planer Co., Cincin., O.
Cleveland Punch & Shear Wks. Co., Cleveland, O.
Detrick & Harvey Mch. Co., Baltimore, Md.
Flather Planer Co., Mark, Nashua, N. H.
Garvin Mach. Co., New York.
Gray Co., G. A., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Niles Tool Works, New York.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Wks., Philadelphia, Pa.
Pond Mach. Tool Co., New York.
Pratt & Whitney Co., Hartford, Ct.
Sellers & Co., Wm., Phila., Pa.
Whitcomb Mfg. Co., Worcester, Mass.
Woodward & Powell Planer Co., Worcester, Mass.

Planers, Portable
Underwood & Co., H. B., Philadelphia, Pa.

Planers, Rotary
Bement, Miles & Co., New York.
Franklin Mach. Wks., Phila., Pa.
Keystone Mach. Tool Works, Philadelphia, Pa.
Newton Mch. Tool Works, Philadelphia, Pa.
Pond Mach. Tool Co., New York.
Underwood & Co., H. B., Phila., Pa.

Presses, Hand
Elmes Engineering Wks., Chas. F., Chicago, Ill.
Chicago, Ill.
Pratt & Whitney Co., Hartford, Conn.

Presses, Hydraulic
Bement, Miles & Co., New York.
Elmes Engineering Wks., Chas. F., Chicago, Ill.
Watson-Stillman Co., New York.

Presses, Power
Bethlehem Fdry. & Mch. Co., So. Bethlehem, Pa.
Bliss Co., E. W., Brooklyn, N. Y.
Perkins Mach. Co., Boston, Mass.

Profilers
Garvin Mach. Co., New York.
Pratt & Whitney Co., Hartford, Ct.

Pulleys
American Pulley Co., Philadelphia, Pa.
Poole & Son Co., Robt., Baltimore, Md.
Reeves Pulley Co., Columbus, Ind.

Pulleys, Friction Cone
Evans Friction Cone Co., Boston, Mass.

Pulleys, Speed Changing
Speed Changing Pulley Co., Indianapolis, Ind.

Pulley Turning and Boring Machines
Harrington, Son & Co., Edwin, Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles Tool Works, New York.

Pumps, Hydraulic
Elmes Engineering Wks., Chas. F., Chicago, Ill.
Chicago, Ill.
Watson-Stillman Co., New York.

Punches, Hydraulic
Bement, Miles & Co., New York.
Watson-Stillman Co., New York.

Punches, Power
Bliss Co., E. W., Brooklyn, N. Y.
Bremer Mach. & Tool Co., Kalamazoo, Mich.
Cleveland Punch & Shear Wks., Cleveland, O.
Hilles & Jones Co., Wilmington, Del.
Long & Allstatter Co., Hamilton, Ohio.
Perkins Mach. Co., Boston, Mass.

Racks, Cut
Standard Gage Steel Co., Beaver Falls, Pa.

Racks, Tool
New Britain Mach. Co., New Britain, Conn.

Rack Cutting Machines
Fellows Gear Shaper Co., Springfield, Vt.
Gould & Eberhardt, Newark, N. J.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Reed Co., F. E., Worcester, Mass.

Reamers
Cleveland Twist Drill Co., Cleveland, O.
Geometric Drill Co., Westville, Ct.
McCrosky & Huber, Cincinnati, O.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Rogers, John M., Boat, Gage & Drill Wks., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Reaming Stands
Flather & Co., Nashua, N. H.

Recorders, Speed
Starrett Co., L. S., Athol, Mass.

Rheostats
Cutler-Hammer Mfg. Co., Milwaukee, Wis.
General Incan. Arc Light Co., New York.

Riveters, Hydraulic
Bement, Miles & Co., New York.
Watson-Stillman Co., New York.

Riveting Machines
Bement, Miles & Co., New York.
Bethlehem Foundry & Mach. Co., So. Bethlehem, Pa.
Chambersburg Engineering Co., Chambersburg, Pa.
Long & Allstatter Co., Hamilton, Ohio.

Riveters, Pneumatic
Bement, Miles & Co., New York.
Cleveland Pneumatic Tool Co., Cleveland, O.
Standard Pneumatic Tool Co., Aurora, Ill.

Roller and Ball Bearings
Ball Bearing Co., Boston, Mass.
Roller Bearing & Equip. Co., Keene, N. H.

Rolling Mill Machinery
Cleveland Punch & Shear Wks. Co., Cleveland, O.
Diamond Drill & Mch. Co., Birdsboro, Pa.

Safety Valves, Pop
Crane Co., Chicago, Ill.
Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

Sawing Machines, Metal
Cleveland Punch & Shear Works Co., Cleveland, O.
Keystone Machine Tool Works, Philadelphia, Pa.
Newton Mach. Tool Works, Philadelphia, Pa.

Schools, Correspondence
Amer. School of Correspondence, Boston, Mass.
Consolidated Schools, N. Y. City.
International Correspon. Schools, Scranton, Pa.

Schools, Technical
Ohio State University, Columbus, Ohio.

Screw Machines, Automatic
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Machine Screw Co., Cleveland, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Screw Machines, Hand
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Mch. Screw Co., Cleveland, O.
Garvin Mach. Co., New York.
Jones & Lamson Mch. Co., Springfield, Vt.
Pearson Mach. Co., Chicago, Ill.
Potter & Johnston Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Warner & Swasey Co., Cleveland, Ohio.

Screw Machinery, Wood and Lag
Baker Bros., Toledo, Ohio.
Cook Co., Asa S., Hartford, Conn.

Screw Plates
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Card Mfg. Co., S. W., Mansfield, Mass.
Hart Mfg. Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Second Hand Machinery
Bowler & Co., Geo. H., Cleveland, Ohio.
Dawson, John H., Chicago, Ill.
Doan & Co., J. B., Chicago, Ill.
Fairbanks Co., Philadelphia, Pa.
Garvin Mch. Co., New York.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mchy. Co., Chicago, Ill.
McCabe, J. J., New York.
Niles Tool Works, New York.
Reade & Co., Wm. A., Cleveland, Ohio.
Prentiss Tool & Supply Co., New York.
Toomey, Frank, Philadelphia, Pa.
Wormer Machy. Co., C. C., Detroit, Mich.

Separators, Magnetic
Sawyer, Ezra, Worcester, Mass.

Shapers
Amer. Tool Wks., Co., Cincin., O.
Bement, Miles & Co., New York.
Cincinnati Shaper Co., Cincin., O.
Flather Planer Co., Mark, Nashua, N. H.
Garvin Mach. Co., New York.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., Boston, Mass.
Kelly Co., R. A., Xenia, Ohio.
New Haven Mfg. Co., New Haven, Conn.
Niles Tool Works, New York.
Perkins Mach. Co., Boston, Mass.
Potter & Johnston Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Ct.
Smith & Mills, Cincinnati, O.
Steptoe & Co., John, Cincinnati, O.

Shears, Power
Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Bliss Co., E. W., Brooklyn, N. Y.
Bremer Mach. & Tool Co., Kalamazoo, Mich.
Cleveland Punch & Shear Wks., Cleveland, O.
Hilles & Jones Co., Wilmington, Del.
Long & Allstatter Co., Hamilton, Ohio.
Perkins Mach. Co., Boston, Mass.

Shears, Rotary
Bethlehem Foundry & Mach. Co., So. Bethlehem, Pa.
Detrick & Harvey Mach. Co., Baltimore, Md.
Perkins Mch. Co., Boston, Mass.

Shelving, Shop
New Britain Mach. Co., New Britain, Conn.

Slotters
Baker Bros., Toledo, Ohio.
Bement, Miles & Co., New York.
Betts Mach. Co., Wilmington, Del.
Franklin Mach. Wks., Phila., Pa.
Garvin Mach. Co., New York.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles Tool Works, New York.

Slide Rests
Reed Co., F. E., Worcester, Mass.

Springs
Cleveland Wire Spring Co., Cleveland, O.

Sprocket Chains
See Driving Chains.

Stamps, Letters and Figures
Schwerdtle Stamp Co., Bridgeport, Conn.

Stampings, Sheet Steel
Automobile & Cycle Parts Co., Cleveland, O.

Steel, Sheet
Automobile & Cycle Parts Co., Cleveland, O.
Ward & Son, Edgar T., Boston, Mass.

Steel, Machinery
Ward & Son, Edgar T., Boston, Mass.

Straightener, Hydraulic
Bement, Miles Co., New York.
Watson-Stillman Co., N. Y. City.

Swaging Machines
Excelsior Needle Co., Torrington, Conn.

Switchboards
C & C Electric Co., New York.
Triumph Elec. Co., Cincinnati, O.

Tapping Machines and Attachments
Baker Bros., Toledo, O.
The Beaman & Smith Co., Providence, R. I.
Bickford Drill & Tool Co., Cin., O.
Cincinnati Mach. Tool Co., Cincinnati, O.
Errington, F. A., N. Y. City.
Fosdick & Holloway Mach. Tool Co., Cincinnati, O.
Garvin Mach. Co., New York.
Geometric Drill Co., Westville, Ct.
Gould & Eberhardt, Newark, N. J.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Webster & Perks Tool Co., Springfield, O.

Taps and Dies
Besly & Co., Chas. H., Chicago, Ill.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Cincinnait Screw & Tap Co., Cincinnati, O.
Crane Co., Chicago, Ill.
Hart Mfg. Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Threading Dies, Opening
Errington, F. A., New York.
Geometric Drill Co., Westville, Ct.
Jones & Lamson Mch. Co., Springfield, Vt.
Modern Tool Co., Erie, Pa.

Thread Cutting Tools
Hart Mfg. Co., The, Cleveland, O.
Rivett-Dock Co., Boston, Mass.

Tool Holders
Armstrong Bros. Tool Co., Chicago, Ill.
McCrosky & Huber, Cincin., O.

Tools
See Machinists' Small Tools.

Trimmers, Wood
Amer. Mchry Co., Grand Rapids, Mich.
Leland & Faulconer Mfg. Co., Detroit, Mich.

Transmission Machinery
Amer. Pulley Co., Phila., Pa.
Caldwell & Son Co., H. W., Chicago, Ill.
Link-Belt Engineering Co., Philadelphia, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Reeves Pulley Co., Columbus, Ind.

Trolleys and Tramways
Brown Hoisting Machy. Co., N. Y. City.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hunt Co., C. W., West New Brighton, N. Y.
Link Belt Engineering Co., Philadelphia, Pa.
Maris Bros., Philadelphia, Pa.
Pawling & Harnischfeger, Milwaukee, Wis.
Whiting Fdry. Equip. Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York.

Turret Machines
Barker & Chard M. T. Co., Cin., O.
Bradford Mach. Tool Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Mach. Tool Co., Bridgeport, Conn.
Cleveland Mach. Screw Co., Cleveland, O.
Dreses, Mueller & Co., Cincin., O.
Garvin Mach. Co., New York.
Gisholt Mch. Co., Madison, Wis.
Grant Tool Co., Franklin, Pa.
Hill, Clarke & Co., Boston, Mass.
Jones & Lamson Mch. Co., Springfield, Vt.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mach Tool Co., Cincinnati, O.
Niles Tool Works, New York.
Pearson Mach. Co., Chicago, Ill.
Potter & Johnston Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Ct.
Warner & Swasey Co., Cleveland, Ohio.
Windsor Mach. Co., Windsor, Vt.

Twist Drills
Cleveland Twist Drill Co., Cleveland, O.
Etna Mfg. Co., New York.
Morse Twist Drill & M. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.

Unions, Brass
Nolte Brass Co., Springfield, O.

Valves
See Steam Fittings.

Vises, Metal Workers'
Hollands Mfg. Co., Erie, Pa.
Parker Co., Chas., Meriden, Conn.
Walworth Mfg. Co., Boston, Mass.

Vises, Pipe
Curtis & Curtis Co., Bridgeport, Conn.
Saunders' Sons, D., Yonkers, N. Y.
Walworth Mfg. Co., Boston, Mass.

Vises, Planer and Shaper
Cincinnati Planer Co., Cincin., O.
Hendey Mach. Co., Torrington, Ct.

Vises, Wood Workers'
Wyman & Gordon, Worcester, Mass.

Welding Machines
Long & Allstatter Co., Hamilton, Ohio.

Wrenches, Drop Forged
Williams & Co., J. H., Brooklyn, N. Y.

Worm Hobbing Machines
Grant Tool Wks., Franklin, Pa.

Worm Gearing
Albro-Clem Elevator Co., Philadelphia, Pa.
Fawcus Mach. Co., Pittsburgh, Pa.
Morse, Williams & Co., Phila., Pa.
Nuttall Co., R. D., Pittsburgh, Pa.

Worm Milling Machines
Cleveland Mach. Screw Co., Cleveland, O.